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THE PEKIN-HANKOW RAILWAY IN CHINA.

By P. H. Ashmead.*

The contract between the Belgian syndicate, which built this railway, and the Chinese Government was signed in 1897, and the concession granted to the syndicate in 1898. Construction was begun in 1899, but was interrupted by what the Chinese now speak of as the "troubles"—that is, the Boxer uprising in 1900. Work was resumed in 1902. The Imperial Chinese Railway had, with English engineers, begun construction on the line from Pekin to Paoting-fu before the concession was granted to the Belgian company, and had graded perhaps a half of this part of the line, which was then turned over to the syndicate. The map, Fig. 1, shows the general line of this railway, together with the other lines built or proposed to be built by other foreign companies. Within the last year, however, China has shown a desire to purchase or cancel her concessions to foreigners for building railways, in order that she may build them herself. She has already purchased the American concession from Canton to Hankow, and desires to make some arrangement for the purchase of the English line from Shanghai to Nankin.

Before the opening of the railway to Paoting-fu, coal and other freight from the south of Pekin was brought in on mules and camels and in ox carts and wheelbarrows, as shown in the accompanying views. Even now wheelbarrow coolies come with a load a distance of 450 li, or about 150 miles.

The Belgian line is about 768 miles long, and the section of it from Pekin to Paoting-fu—both of which are in Chili Province—is about 150 kilometers. It is constructed between these two points, both as to roadbed and openings, for a double-track line, although but one track has been laid. It is of standard gage—4 ft. 8½ ins.—which the Chinese authorities have wisely required in all concessions for railways in all parts of the Empire, with the exception of the French in the south towards Indo-China.

The rails are in the metric equivalent of about 75 lbs. per yard, laid with even joints to prevent rocking of the trains on the new embankment. Ties are mostly of soft wood, 6 ins. × 8 ins. × 7 ft., laid at various places along the line from 9 to 13 per 30 ft. rail, the average being, however, 12 to the rail, fastened with screw spikes, with tie plates on alternate ties. Six-bolt fish plates are used.

The line is well ballasted throughout. To Paoting-fu with gravel, about 8 ins. to 10 ins. deep under the ties, they being also covered with ballast to a depth of nearly 2 ins. South of Paoting-fu a single track embankment only has been constructed, upon which the ballast has been carefully laid to a line, as on many parts of the Pennsylvania system.

Through the flat country of the north, across which strong winds blow, willows have been planted for protection against drifting sand and dust. These are growing well. To Paoting-fu and for 100 miles south of it the roadbed now seems compact, and smooth riding. A speed of 40 miles per hour is sometimes made between stations—the average, however, is probably not more than 22 miles an hour, as longer stops are necessary at the stations than in America. The Chinese carry huge bundles of baggage, and delays are frequent.

With the exception of the terminal and divisional points, at which larger quarters have been erected, the stations along the whole line are of brick with tile roof, apparently well constructed, and with plenty of room for the present needs. In addition to separate rooms, or sections divided by fences, for the three classes of passengers carried, there are a small baggage or freight room, an office and living quarters (usually one room) for the French speaking Chinese ticket agent. Fig. 5 shows a typical station. The station platforms are made by filling between two vertical walls of brick, having a granite, limestone or concrete coping. The top surface of the platform is of fine gravel or cinders.

All the rolling stock is light and of the ordinary continental European design, with the exception of the third-class passenger cars. This is true of all the rolling stock at present used in China, except that used on the (formerly) American Canton-Hankow Railway in the south—the passenger and freight cars there being of American design.

On the Belgian road, the freight cars, or "wagons," are of 8, 10 and 12 metric tons capacity, with four wheels and the couplers and chains used on the continent of Europe. The road has, however, a few cars of about 20 tons capacity.

The third-class passenger cars have long wooden seats on each side, with another long one sometimes placed in the middle of the car. The inside is ceiled and racks are placed above the seats—most of the baggage is, however, placed between the feet and legs of the owners, as the possibility of loss causes each Chinese to want his belongings constantly within his sight. Other third-class cars have no seats nor racks, passengers either lying or squatting on the floors, possibly a more pleasant position for the Chinese coolie, as one sees them apparently perfectly comfortable, squatting for hours on their heels.

Before the completion of the road, the gondolas were frequently used for the third-class pas-

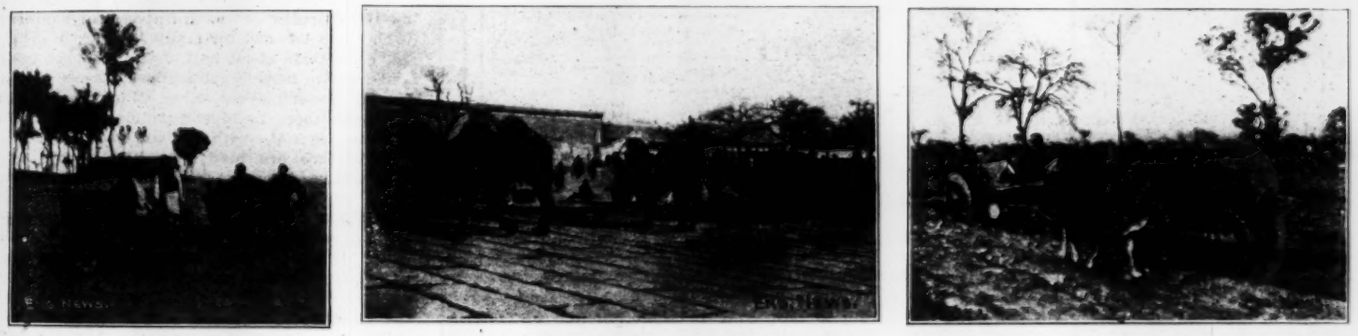


FIG. 3. PRIMITIVE TRANSPORTATION IN CHINA.

Fig. 2. Pekin, Wall and Gate on South Side of the Tartar City.

*Late Engineer-in-Chief, Canton-Hankow Ry. At present with J. G. White & Co., Inc., New York City.

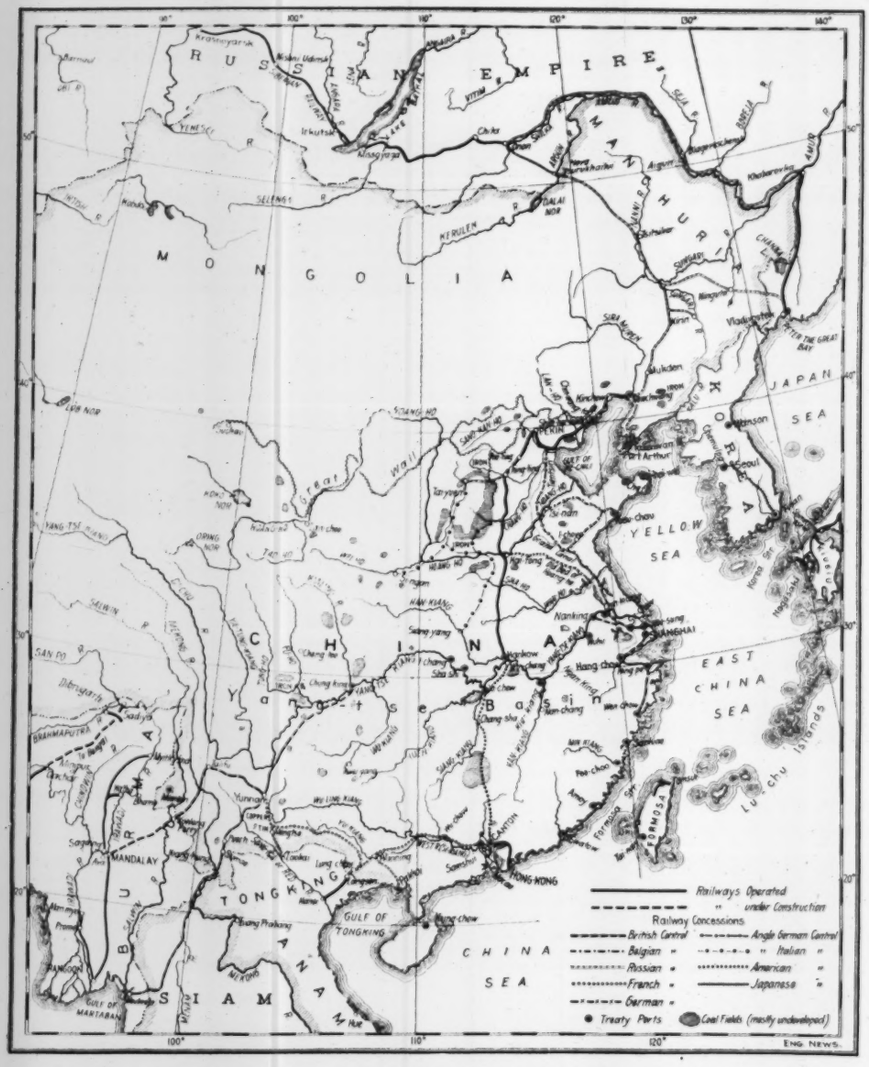


FIG. 1. THE RAILWAYS OF CHINA, EXISTING AND PROJECTED.

sengers, causing much criticism from Europeans as to the foreigners' treatment of the Chinese, but, of course, only from those who were not used to the exigencies of construction.

The second-class cars are externally much the same as the third-class. The interior is, however, divided into sections boarded half way to the roof, but open toward the aisle, with seats for four persons in each section. Some of this class have the sections through one-half of the car only, the other half being used as a place for preparing meals, with an attendant to prepare food, and a stove, tables and benches.

The first-class cars are divided into compartments, upholstered with leather, and each compartment seats six persons comfortably. The main difference between them and the European cars of the same class is that doors are at each end of the cars, allowing passage through the whole train, instead of from each compartment to the platforms at stations. Toilet compartments are in all first and second-class cars.

It was expected that the sleeping and dining cars of the International Sleeping Car Company (Compagnie des Wagon-lits Internationale) would be received by February, 1906, after the receipt of which European passengers could stay in them instead of going to the Chinese hotels. Later, the railway company will make an effort to run passenger trains at night, and reduce the time of passage between Pekin and Hankow to a little less than 40 hours.

The railway also has private cars which may be chartered for about $60, gold, for the trip from Pekin to Hankow. The limited number of these cars, however, requires several days notice to insure an engagement. These cars accommodate from four to eight persons, with apartments for Chinese servants, as well as toilets, and conveniences for cooking, dining and sleeping.

The train from Pekin is composed, usually, of eleven coaches, of which two are first, three second and five third-class, and a private car.

It may be of interest to note that the glass in the windows of nearly all coaches is colored. When clear glass was used, the Chinese were not accustomed to it, and broke many panes, and cut many heads in striving to look out.

The locomotives are of the European type, as shown in Figs. 6 and 7. Those for the lo... have been provided with a pilot, as in A... At present no passenger trains are run ... on any of the railways in China. On t... Imperial Chinese Railways North, "goo... freight trains are sometimes run after da... not all through the night.

Over the Belgian Railway the train from ... south starts at 7 A. M. and arrives at Sh... at 6.15 P. M., where it stops for the night. ... the advent of the railway, an hotel has ... built here at which foreigners may stay and ... fairly good accommodations. The train ... the Yellow River also stops here for the ... and the next morning the train that came ... the north returns to Pekin, and the privat... are attached to the Yellow River train ... its return trip. The country still remains fla... and one easily understands how the Yellow ... changed its course by some hundreds of ... and destroyed some hundreds of thousan... of lives—supposedly over a million.

The second day a few camel trains are ... still seen, and many more pack mules coming from the coal mines in the region near Tze-chou, where the Pekin syndicate hopes to develop mines.

But a short run is made this day, as the train stops for the night at Sin Siang-sien, about 50 kilometers north of the Yellow River bridge, there being no town nor accommodation for passengers nearer the river. It is an interesting town to the foreigner, and like most of the interior towns of China has the narrow, unpaved streets, generally filthy, and during the day time usually crowded with people. Ancestral temples and pagodas of brick are crowded by the small houses of the people within the walled city. The people are curious, but not unfriendly, and since the railway came are rather indifferent to foreigners, although there are still enough of them who have never seen a foreigner to cause one to be followed by an investigating crowd.

The Yellow River is reached at about 8 A. M. on the morning of the third day, and until the bridge can be used for regular traffic, passengers leave the train about half a mile from the bridge, and trust to luck to get further, the management having no employee, either Chinese or foreign, stationed there to give directions. It is necessary to negotiate with the wheelbarrow men—of whom there are many—for the transportation of baggage from the train to the edge of the river, climb down the high embankment, walk to the boats, and then make another negotiation with a sampan captain for passage across the river. If one is acquainted with Chinese methods of bargaining, it is possible to accomplish all of this for one or two Mexican dollars, according to the amount of baggage carried.

The trip across the river by boat consumes from 1½ to 5 hours. Sand bars form and vanish quickly, and there is always the possibility of their forming in such a way as to confine the sampan in a miniature lake completely cut off from the main stream. The Yellow River dragon is a peculiar individual of his kind, and according to the Chinese belief must be propitiated in a manner different from the dragons in other waters. Many of the sampans are built in two

Fig. 4. Culvert Opening Near Sin Yang Tchow, on Pekin-Hankow Ry.

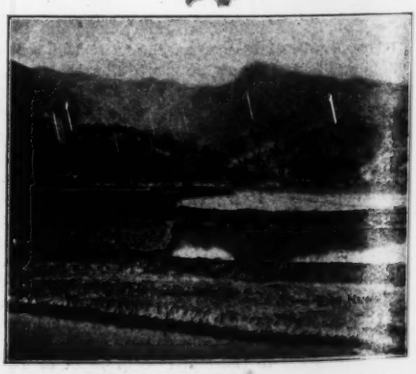
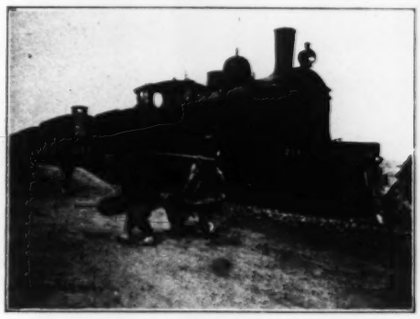


Fig. 10. Terraced Farms Near Li Kai Tsai, ...pei Province.

Fig. 5. Typical Station at Wei-Hui-Fou.



FIGS. 6 AND 7. TWO TYPES OF LOCOMOTIVES; PEKIN-HANKOW RY.

sections, so that when one part sticks on a bar, it may be lightened by transferring its cargo to the second section and thus be refloated. Fig. 8 shows the ordinary Yellow River sampan for cargo service. The Chinese are truly remarkable in their ability to maneuver their boats against the swift currents, the winds and other wiles of the dragon, by means of a rope attached to both anchor chain and rudder.

As may be seen in Figs. 9 and 11, the Yellow River bridge is simple in design and light in construction. It is about 3 kilometers in length. The spans are 20 and 30 meters in length, and the piers are built on screw piles made in sections 2 meters long, bolted together, and afterwards filled with concrete. The disks on the piles are 30 centimeters in diameter.

The design of the piers seems well adapted to such a stream as this river, in making a minimum obstruction to the waterway, but they have not yet been subject to the stresses of a flood, none having occurred during its construction. The Belgians claim to have made very thorough tests as to the weights borne by these piles—in Europe—before the bridge was erected, and seem satisfied the bridge will withstand any flood, which may possibly be considered doubtful until after a flood, as difficulties have been encountered in holding to line and grade piers 16 and 17 from the north abutment. This has prevented (up to December, 1905) regular traffic over the bridge. The foundation screw piles are driven to various depths up to 20 meters. Some years before another syndicate had investigations made near this crossing, and their consulting engineer found no solid foundation by boring with 75 ft. of gas pipe.

Several piers have been protected with rip rap. The banks are also being protected with willow mattresses about 2½ ft. thick, pinned down with stakes about 4 × 4 ins. and 5 to 8 ft. long, driven through them.

Chinese guards with rifles are placed at each end of this structure, and each station is also guarded by from 4 to 10 guards, two of whom are armed with rifles, while the others carry stout sticks. The guards have been well drilled and neatly uniformed, and stand in line at attention along the platform until the train leaves.

From the south side of the bridge, in the Province of Honan, a jerkwater train leaves at 11 A. M., taking the passengers who have succeeded in crossing the river, and arrives at Tsen Techeou, a division station, at 11.20 A. M., where a change is made to the through train for Hankow, which leaves at noon. Passengers who have chartered private cars are changed to other private cars, or to first-class cars, which have been kept south of the bridge. This train runs until 7.30 P. M. through a country almost as flat as that from Pekin south, with the exception of the last two hours, which is through ground rather badly broken by the loess formation.

The fourth morning the train leaves at 7 o'clock, and begins a climb into the hills about

Fig. 8. A Chinese Sampan; Passenger Transfer Across the Yellow River.

an hour later. The track is all well ballasted with broken stone, and the slopes of the cuts are almost always to a true plane. The Chinese laborer is fond of trimming up, and in places not only "sandpapers" but almost polishes. Through the earth cuts rock drains have been laid in the slopes to prevent slides, and the track gangs—usually of from 6 to 12 men under a Chinese foreman—keep the ditches clean. Grades do not exceed 1%. The valleys are well cultivated, as shown in Fig. 10, mostly rice paddies irrigated from the mountain streams.

At 2 P. M. the train runs from the hills into flat country again through Hupeh Province, and reaches Hankow at 6 P. M., having averaged about 15 miles an hour, including stops at stations, for the 300 miles from the Yellow River south.

Much of the construction of this railway was done by foreign (continental European) contractors, with, of course, Chinese sub-contractors and laborers. Ordinary coolies in the north receive from 7 to 20 or 25 cents gold per day, while masons, carpenters, firemen and locomotive drivers receive from 20 to 50 cents gold per day. The Chinese laborer will do from one-fourth to one-half as much work per day as an ordinarily good laborer in the north of the United States, and there is as much difference in the work done by individual laborers there as there is with our own labor. Many of the Chinese could do more than they do now if they were well, or rather, differently, fed. As is well known, their principal food is rice, with occasionally a few pieces of meat or fish. The grading alone cost approximately $20,000 gold per mile for the whole line.

The purchase of land and graves was arranged for by Chinese officials appointed by the Director General of Imperial Chinese Railways, payment being made according to prices arranged by them. The price of land varied according to its location, and while the prices of graves also varied, the average was about four taels (about $2.80 gold) per coffin. There being no graveyards in China, as with us, and the location of each separate coffin having been chosen previously by a geomancer, according to immemorial Chinese custom, it required much tact on the part of the Chinese and foreign officials of the railway to accomplish the removal of the coffins from the right of way, as the graves cover much of the ground, being thickly scattered over the arable land as well as on the hills and mountains.

Passenger tariffs per mile are approximately 3 cents for first-class, 2 cents for second-class and a fraction less than 1 cent for third-class, the prices of all fares being in multiples of five cents, in order that "cash" and other copper pieces may not be received.

A detailed freight tariff book, fully covering all articles liable to be shipped, has been prepared and printed, from which the following approximate tariffs may be quoted: Coal, 1.8 gold cents per ton-mile; powder and dynamite, 20.8 gold cents per ton-mile; grain, rice, etc., 2.9 gold cents per ton-mile; machinery, timber, etc., 2.3 gold cents per ton-mile.

The Engineer in Chief, who is also the executive officer in the operation of the whole line, is Mr. Jean Jadot.

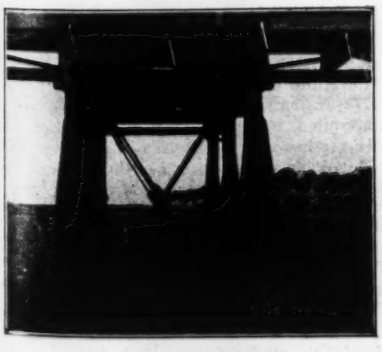


FIG. 9. SCREW-PILE PIERS OF THE YELLOW RIVER BRIDGE.

Fig. 11. View of the Yellow River Bridge.

SHOP EXTENSIONS AT THE PLANT OF THE ALLIS-CHALMERS CO., MILWAUKEE, WIS.

In 1901 the Edward P. Allis Co., of Milwaukee, Wis., built large new works at the industrial suburb of West Allis, and the plant and building construction were described and illustrated in our issue of May 23, 1901. The plant was designed by Mr. Edwin Reynolds, M. Am. Soc. M. E., then Vice-President and Superintendent of the company, with a special view to economy in the shop work and manufacturing processes and the economical handling of large and heavy pieces of machinery, and also with a view to the future systematic enlargement of the plant. More than a year ago the Allis-Chalmers Co. (successor to the old company) found it necessary to provide for extensive additions to increase the capacity of the plant, and this work is now well advanced. The general scheme is shown in the plan, Fig. 1. There are three parallel buildings running north and south; A, the pattern storage and pattern shop; B, the foundry; C, the erecting shop. In the wide space between the two latter, and connected to the erecting shop, are lateral buildings for the machine shops and blacksmith shops. An overhead traveling crane runs along the 93-ft. yard between the pattern shop and foundry, while similar cranes are provided in all the 66-ft. lateral yards between the several machine shops; these latter cranes also extend across the 123-ft. yard to the foundry, so as to serve the railway tracks in this yard. The new buildings are of steel frame construction, with columns spaced 16 ft. c. to c.; the walls are of brick, with a thickness (between pilasters) of 13 ins. in the sides and 17 ins. in the ends.

It will be seen from the plan that in enlarging the plant the three longitudinal buildings have been extended to about twice their original length and that three additional lateral shops are provided. These shops, however, are 145 ft. and 168 ft. wide as compared with 122 ft. for the older shops. The purposes for which these lateral shops are assigned are as follows: Nos. 1 and 2, machine shops for engine work; No. 3, blacksmith shop; No. 4, steam turbines; No. 5, electrical apparatus; No. 6, electrical apparatus, winding department and the assembling of small apparatus. The buildings were designed by the company's own staff.

EXTENSION OF LONGITUDINAL BUILDINGS.—The structural designs of the extensions of the erecting shop, foundry and four-story pattern shop are identical with those of the older portions of these buildings, which were described in our issue of May 23, 1901, and need not be further referred to here. It may be stated, however, that the erecting shop has a central bay 72 ft. 6 ins. wide, with a clear height of 72 ft. 6 ins. to the roof trusses, and two 38-ft. side bays of 32 ft. clear height. The extensions are 424 ft. 6 ins. long for the foundry and pattern shop, while that of the erecting shop is 590 ft. long. The steel work for these extensions was built and erected by the Riter-Conley Mfg. Co., of Pittsburg, Pa. For the erection, a steel traveler was used, of the design shown in Fig. 2. The view in Fig. 3 shows the traveler engaged in distributing material preparatory to its erection, and Fig. 4 shows the steel framing of the four-story pattern shop, with the traveler in position. The traveler weighed about 35 tons and was carried on four 18-in. flanged wheels on a track of 35 ft. gage. The platform was 36 × 38 ft., and the superstructure consisted of rectangular bents surmounted by two triangular bents, connected by bracing to form a tower 100 ft. high in front. At the front end were two 65-ft. latticed steel booms pivoted at the top of the rectangular bents and supported by topping lines from the top of the triangular bents. Each of these had a hoisting capacity of 12½ tons, and a maximum reach of about 123 ft. vertically from the ground and about 85 ft. horizontally from the center of the traveler. In distributing material in the yard ready for erection, the length of each boom was temporarily increased to 71 ft. by a 12 × 12-in. timber lashed to the end, as shown in Fig. 3. The hoisting, slewing and topping lines of the two booms were all handled by a 40-HP. hoisting engine, with six spools, mounted on the platform. The foundry is wide and the erecting shop and four-story pattern shop are high, but the traveler was found very efficient for the work on all these buildings.

NEW LATERAL BUILDINGS.—The three new buildings, Nos. 4, 5 and 6, extending laterally from the extension of the erecting shop, are of different design from the older lateral buildings, owing partly to requirements for the special work which will be done in them, as already noted. Buildings Nos. 4 and 5, however, are identical, and each has two spans of 66 ft. 7 ins. and 71 ft. between columns, as shown in the cross section, Fig. 5. In the smaller span there is a clear headway of 52 ft. 6 ins., except for a 21 ft. gallery along one side. The longer span has two floors, and is subdivided by a row of columns, the upper floor being carried by 36-in. plate girders designed for a load of 400 lbs. per sq. ft. These girders are 16 ft. apart, and carry a floor composed of 2 × 10-in. stringers placed close together and covered with a diagonal course of ⅞-in. planking and a wearing surface of 1-in. maple. The main floor is of plank on stringers embedded in cinder filling. The columns are of

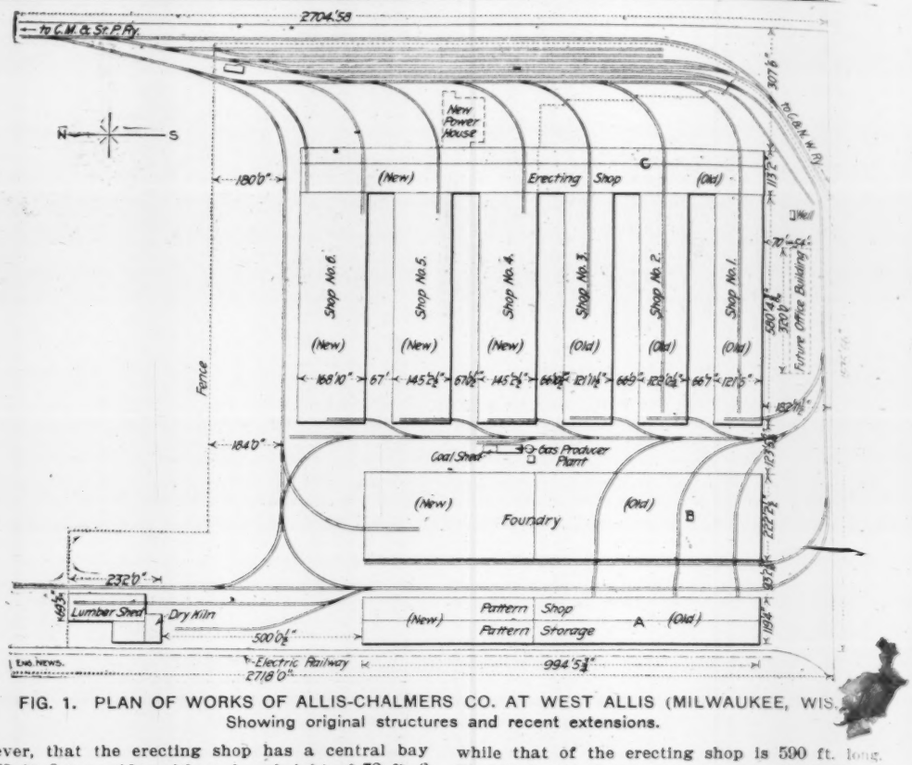


FIG. 1. PLAN OF WORKS OF ALLIS-CHALMERS CO. AT WEST ALLIS (MILWAUKEE, WIS.). Showing original structures and recent extensions.

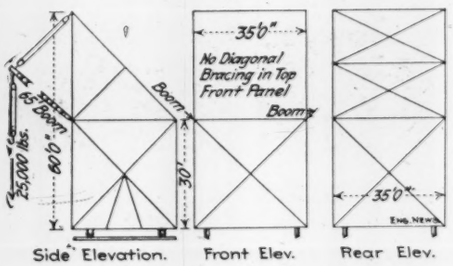


Fig. 2. Traveler Used in Erecting the Foundry, Pattern Shop and Erecting Shop.
Riter-Conley Mfg. Co., Pittsburg, Pa.

FIG. 3. TRAVELER DISTRIBUTING MATERIAL.
(Steel Beams Lengthened by Timbers.)

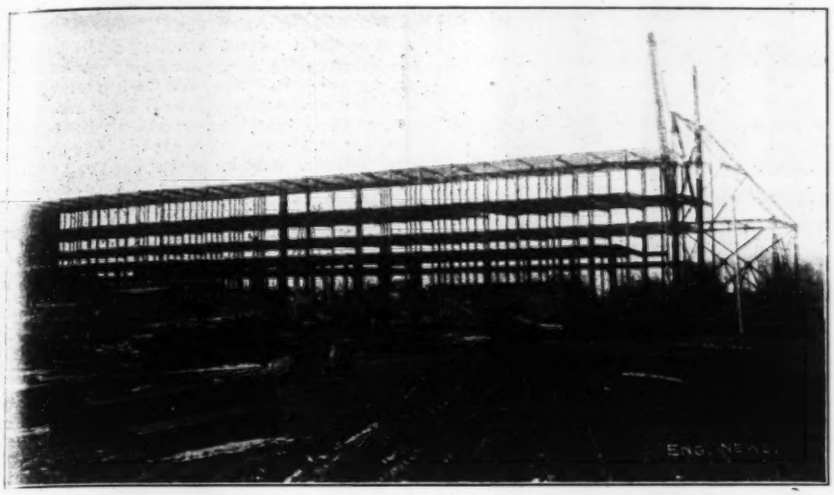


FIG. 4. STEEL FRAME OF PATTERN SHOP AND STORAGE BUILDING, WITH TRAVELER IN POSITION.

I-beam section, built up of a web plate and four angles. The roof trusses are of simple design, with the top chords slightly inclined, and above these are wide skylights in place of the usual monitor construction with side windows or louvres. Ventilators are provided along the ridge of the roof. The roof has a plank sheathing, covered with tar and gravel composition. Each 60-ft. main truss is designed to carry on the bottom chord a concentrated load of at least 2 tons at any point in any panel, or two similar loads in adjoining panels. Each 71-ft. truss is designed to carry a load of shafting, trolleys, etc., equal to 35 lbs. per sq. ft., uniformly distributed, but the bottom chord is strong enough to carry a concentrated load of at least 2 tons at any point. The assumed roof load on the trusses is 45 lbs. per sq. ft.; this includes roofing, skylight and snow, but not the trusses or skylight framing.

Building No. 6 is 168 ft. wide and is U-shaped in plan, the two sides and the west end being four stories high, while in the middle is a light court, 55 ft. wide. At the bottom of this court the first floor is covered by a roof supported on two rows of triangular trusses. The general construction is shown in the cross section, Fig. 6. The floor construction is the same as in buildings Nos. 4 and 5, and is designed for loads of 300 lbs. per sq. ft. on the second and third floors, and 200 lbs. on the top floor. The main roof trusses are designed for loads similar to those of the two other buildings, while the roof load for the low 26-ft. spans of the court is taken at 55 lbs. per sq. ft.; this includes the roofing, skylight and snow. It will be seen that this building is well provided with crane equipment, there being electric traveling cranes of 3, 5 and 10 tons capacity. In fact, the additions to the plant will include 34 electric traveling cranes of 3 tons to 60 tons capacity; the largest is for the foundry and has a 10-ton auxiliary hoist. All these were built by the Pawling & Harnischfeger Co., Milwaukee, and their electric motor equipment represents a total of about 1,953 H.P. With the cranes by the same makers already installed in the older shops, the plant will have in all about 74 cranes with motors aggregating 4,086 HP

The steel work for these buildings was built and erected by the American Bridge Co. Buildings Nos. 4 and 5 are identical, as above noted, and were erected in the same manner. The traveler in No. 4 was of timber construction, with a wheelbase of 30 ft., and having masts 37 ft. high and two 54-ft. booms on the forward end. Work was in each case commenced at the east end, and the traveler was placed first on the north side of the higher bay or span, so as to erect columns B, C and D (Fig. 5), the roof trusses of the high bay, and the south half of the trusses of the low bay; it also erected the plate girders between B and C, and the material for the mezzanine floor. Between columns A and B, a temporary track was laid for a derrick car with 53-ft. boom. This set columns A, the north half of the low roof trusses, and the heavy floor girders between A and B. In building No. 5, the traveler was one of the American Bridge Co.'s standard 12-ton travelers of steel construction, with 30-ft. wheelbase, 30-ft. masts and two 50-ft. booms. The derrick car in this building had a 40-ft. boom, with extension for erecting the light latticed struts in the A and B rows of columns. The track for this derrick was connected with a track in building No. 6, so as to use the derrick in unloading and distributing material for this building. For the actual erection, the timber traveler already mentioned was moved to the center of No. 6, this one traveler doing all the work. For the present, however, the north four-story wing is omitted, and will be erected later.

The lighter work, such as bracing, tie rods, purlins, etc., was erected by a house gang working in advance of the riveting gang. All work is riveted, except that the purlins are bolted and the crane rails clamped. Compressed air was used for riveting, a 20-HP. Fairbanks-Morse gasoline engine compressor plant in the power-house furnishing the air for seven gangs of riveters. A similar plant of 12-HP. was afterwards installed to supply additional gangs. Buildings Nos. 4 and 5 formed one contract, and required about 3,847 tons of steel work, most of this being manufactured at the Milwaukee shops of the American Bridge Co. No. 6 will comprise about 3,000 tons, only half of which will be erected at this time. The steel work for this building is being manufactured at the company's shops at Toledo. The inspection was in charge of the Pittsburg Testing Laboratory, and the painting will be done by the Allis-Chalmers Co.

NEW POWER-HOUSE.—The present power-plant occupies about a third of building No. 3, at the west end, but is to be removed to a new power-house east of the erecting shop, as shown in the plan, Fig. 1. This will be of brick construction, one story high, with engine room 156 × 59 ft.; boiler room, 103 × 74 ft., and heating plant room, 18 × 29 ft. There will be a coal

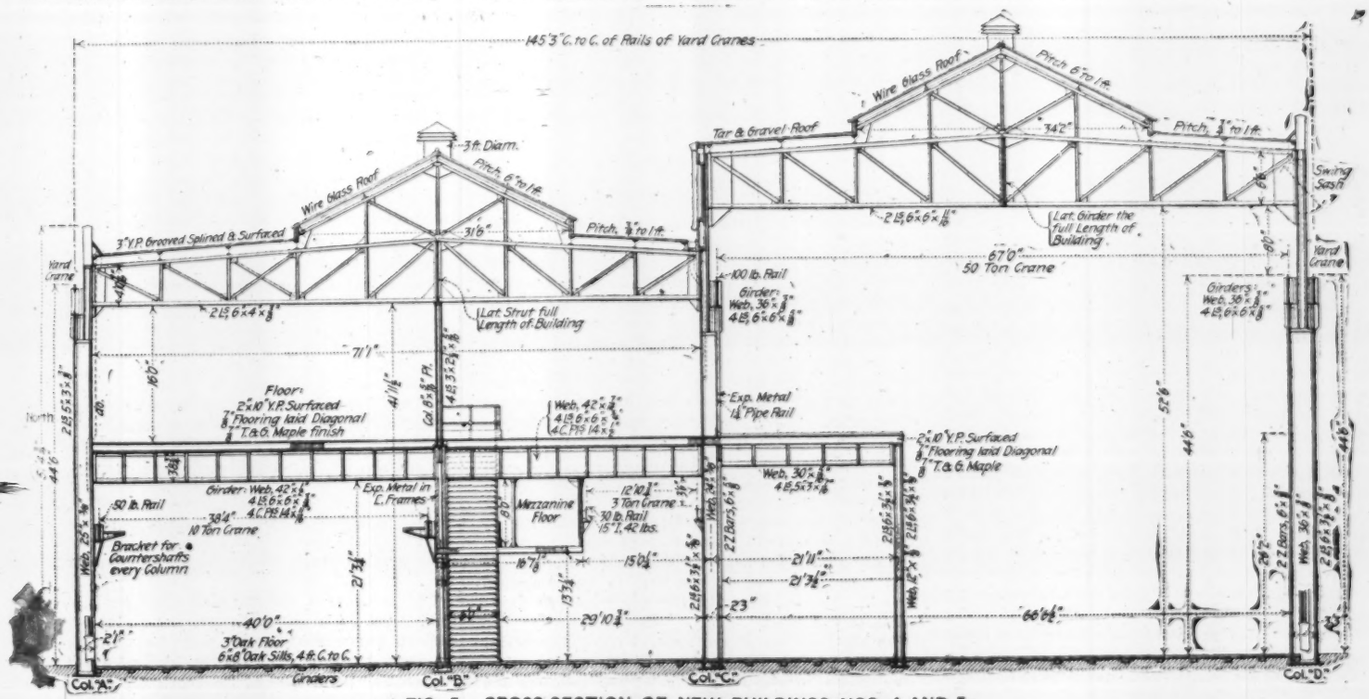

145'3" C. to C. of Rails of Yard Cranes
Wire Glass Roof
Pitch 6" to 1ft.
Tar & Gravel Roof
Pitch 3/4" to 1ft.
3ft. Diam.
Swing Sash
3" Y.P. Grooved Splined & Surfaced
Lat. Girder the full Length of Building
67'0"
50 Ton Crane
Yard Crane
Lat. Strut full Length of Building
100 lb. Rail
Girder: Web, 36" × 3/8"
Girders: Web, 36" × 3/8"
71'1"
Floor: 2"×10" Y.P. Surfaced 7/8" Flooring laid Diagonal 1/8" T.&G. Maple Finish
Exp. Metal 1/4" Pipe Rail
2"×10" Y.P. Surfaced 7/8" Flooring laid Diagonal 1/8" T.&G. Maple
Girder: Web, 42" × 7/16"
50 lb. Rail
10 Ton Crane
Exp. Metal in 'L' Frames
Mezzanine Floor
12'10"
3 Ton Crane
30 lb. Rail
15'7", 42 lbs.
Web, 30" × 7/16"
Bracket for Countershafts every Column
40'0"
3" Oak Floor 6"×8" Oak Sills, 4 ft. C. to C.
Girders
Col. "A"
Col. "B"
Col. "C"
Col. "D"

FIG. 5. CROSS-SECTION OF NEW BUILDINGS NOS. 4 AND 5.
American Bridge Co., New York, Contractors.

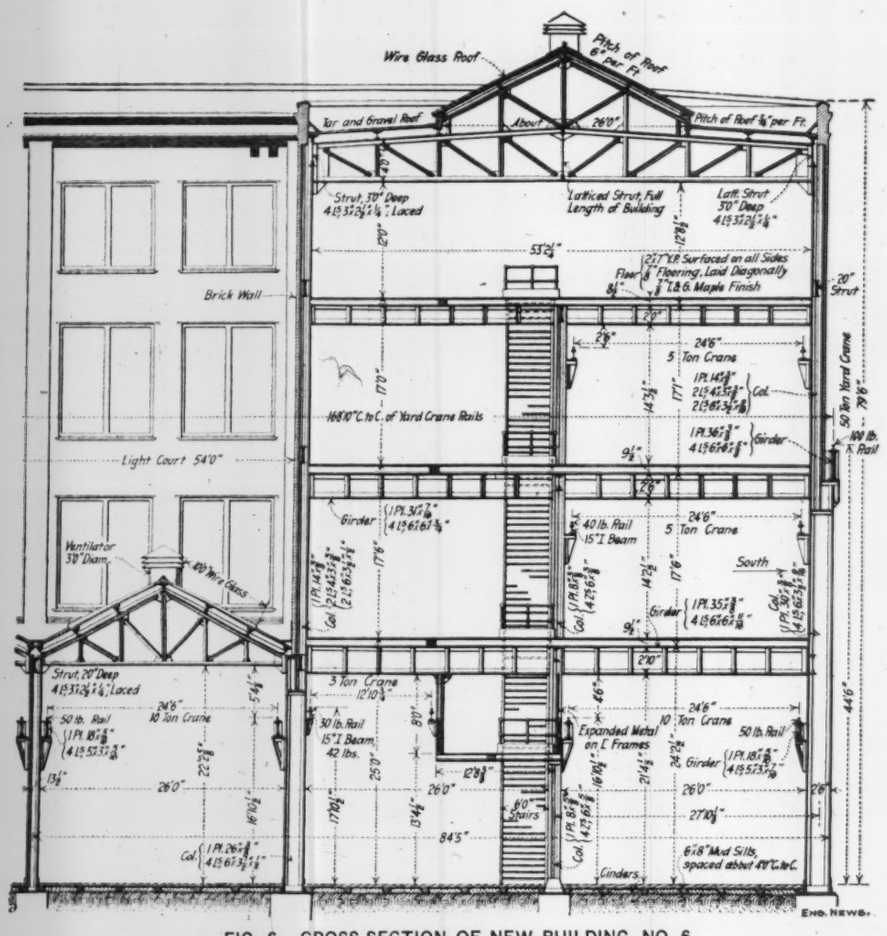


FIG. 6. CROSS-SECTION OF NEW BUILDING NO. 6.
American Bridge Co., New York, Contractors.

storage bin of 700 tons capacity, or enough for 15 days. The coal from the cars will be passed through a breaker and delivered to a conveyor plant, which will also handle the ashes. The boiler room will have seven Edge Moor boilers of 625 HP. (five to be installed at once), with underfeed stokers supplied from overhead coal bins. For each pair of boilers there will be a self-sustaining steel smokestack, 7 ft. inside diameter and 100 ft. high. The engine room will be served by an electric traveling crane, and will contain the following as the principal power equipment: Two turbine generator units of 1,500 KW. and 500 KW., one cross-compound engine generator unit of 750 KW., and an air compressor. The details of the power plant equipment, however, have not yet been determined.

THE DESIGN OF REINFORCED CONCRETE COLUMNS AND FOOTINGS.*

By Edward Godfrey.†

INTRODUCTION.—In the paper published in Engineering News of March 15, 1906, the writer derived some simple formulas for the design of reinforced concrete beams and slabs and some rules governing the proper proportioning of the steel for reinforcement and the limiting span length. Accepting the premises given in that paper, it becomes a simple matter to design beams and slabs in this comparatively new combination of materials. There seems to be no voice lifted up to deny the complete safety of beams thus designed to carry their loads, and no substantiated objection to the proposed method of design has yet been raised on the side of economy—the other end of the see-saw that the engineer must maintain in equilibrium.

Many so-called practical tests have been made on reinforced concrete construction in place that do not merit the name of tests. They are made on a small section of a floor supported on all sides by the contiguous construction, and do not test in any adequate sense the part of the floor immediately loaded. If a designer of steel construction should load a beam by placing a uniform load on a fraction of its length and declare that from the results of the "test" the beam is shown to be capable of carrying that uniform load throughout, he would be promptly ruled out; and yet this is the kind of test that is commonly held up as demonstrating the ability of some forms of concrete-steel design to carry enormous loads. Careful tests of isolated beams have been made in large numbers, which have proven with practical agreement the correctness of the premises and rules of proportion as well as the resulting formulas obtained by the writer in the paper above referred to.

On account of enquiries and criticisms that the writer has received from different sources, it is thought to be in place to amplify the former paper on beams and slabs by what immediately follows.

Tests have shown that rods of a greater diameter than about 1-200 of the span are apt to pull out of the concrete without breaking, on account of the lack of length in concrete to grip the metal effectually. Other tests have shown that beams having a greater depth than one-tenth of the span and containing horizontal rods at the bottom, or having rods turned up at the support and not anchored at the ends, will fail when loaded to destruction, approximately as per sketch Fig. 1. This demonstrates the inability of the concrete in beams so designed to carry the end shear, vertical and horizontal (which combine in the diagonal line in the figure), when the depth exceeds one-tenth of the span.

On the location of the neutral axis, theoretical methods of determining its position by the relative moduli of elasticity of steel and concrete are unsatisfactory, on account of the wide variation in the modulus of elasticity of concrete as determined by compression tests. There is, however, a more direct method of locating this axis, one which gives more concordant results, namely, by measuring the relative extension or shortening of the lower and upper fibres of a beam under test. In a letter replying to a critic on this phase of the subject the writer made the following defense of his position, which is here repeated to make this paper complete of reference:

"In Engineering News, July-December, 1904, pp. 125, Prof. Talbot gives plottings of the position of the neutral axis. For 1.39% reinforcement the distance from top of beam is almost exactly 50% of the depth from top of concrete to steel. For 0.97% it is about 0.42 of the same depth. Prof. Talbot gives this formula for finding the position : $k = 0.28 + 0.18\ p$, where k is the fraction of the depth from top to neutral axis and p is the percentage of steel. For 1¼% of this would be 0.485 of the depth from top of concrete to steel. Prof. F. E. Turneaure in Engineering News, July-December, 1904, p. 215, says: 'The diagrams show the neutral axis to be at first very near the center of the concrete beam. As the cracks develop it moves gradually nearer to the compression side'."

On the proper percentage of steel the writer's paper was also criticised by the person to whom the reply in the last paragraph was directed. This critic stated that 1¼% is too large a percentage of steel. This criticism is correlative with the one on the location of the neutral axis. A higher location of that axis means a less percentage of steel, since it affords a larger lever arm or effective depth in the resisting moment. The writer's reply to this criticism was as follows: "As to 1¼% being too high, I quote from Prof. A. N. Talbot, in Engineering News, July-December, 1904, page 125: 'For 1 : 3 : 6 concrete, reinforcement as high as 1½% for steel of 33,000 lbs. per sq. in. elastic limit * * * may be used without developing the full compressive strength of the concrete.'" The proportions of concrete that I recommend are 1 : 2 : 4, a much stronger concrete, generally, than 1 : 3 : 6; it would allow a greater percentage of steel. Again, to quote Prof. W. Kendrick Hatt, in "Engineering Record," Vol. 51, page 545: "In the writer's tests of beams under a center load 2½% of steel failed to develop the crushing strength of the concrete." In Engineering News of Feb. 15, 1906, page 170, Mr. J. J. Harding states that for steel of an elastic limit of 35,000 lbs. he would use between 1 and 1¼% of the area of the concrete. Mr. T. L. Condron, in a paper read before the Western Society of Engineers, March 15, 1905, says: "For extra strong concrete of about 1 of cement, 2 of sand and 4 of broken stone, the percentage of reinforcement may be increased to 1.25%." (This in a discussion of 202 tests.)

The writer has been asked why he does not use the floor slab in connection with the beam as top flange, making a tee beam out of it. The buckle plate in a steel floor would not be used as top flange of the floor beams, though it may be secured firmly to the beams; and there is no good reason for using the concrete-steel floor slab as part of the beam. The slab is spread out too much for a proper distribution of the stresses, and it may have holes cut into it for pipes, etc., thus destroying its value as beam flange. Again, to include it in the calculations would add largely

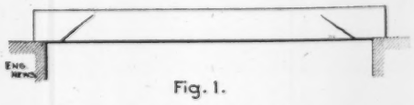


Fig. 1.

to the percentage of steel in the lower half of the rectangle of the beam. The rectangle of concrete should not be called upon to take care of more than about 1¼% of steel. Practically the only saving effected by counting in the slab is in the amount of concrete in the lower part of the beam. The concrete is needed there to protect the steel against corrosion and fire, and generally to give width enough to the beam to take care of the horizontal shear.

The subject of the limiting load that a concrete-steel beam of the proportions given in the former paper may carry may be amplified as follows: Assuming the neutral axis of a beam to remain in the middle of its depth for safe load, it is seen that the safe resisting moment of the

*A paper supplementing one on the "Design of Reinforced Concrete Beams and Slabs," published in Engineering News, March 15, 1906.

†Monongahela Bank Building, Pittsburg, Pa.

beam is directly proportional to the amount of steel. For steel in less amounts than 1¼% the stress in the concrete is less than 2,000 lbs. per sq. in. with 40,000 lbs. per sq. in. on the steel, but cases may arise where it is more economical to increase the relative amount of concrete. If the depth of a beam be doubled, its resisting moment

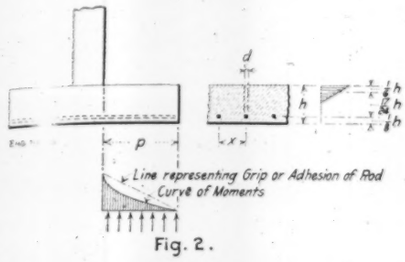


Fig. 2.

per foot of width will be four times as great, assuming that the steel is still 1¼%; that is, that the steel is doubled also. Now, if the amount of steel in the beam of double depth be divided by two, the resisting moment will be one-half as great. In other words, if the same rods be used in a beam of twice the depth, the resisting moment is doubled. The weight of the concrete and the depth of the beam are, of course, twice the values in the original beam, and these may be objectionable when the double strength could be obtained by using a beam 1.4 times as deep, with 1¼% of steel. However, where a large increase in depth and weight of concrete are not objectionable, the limiting ultimate load of 4,080 lbs. per sq. ft. on the top surface of the beam may be increased without necessitating the curving up and anchoring of some of the rods. Thus, if the limiting beam of one-tenth of the span be doubled in depth, with the same steel, it will have twice the strength and also twice the shearing area at the ends; hence it will have twice the ultimate capacity. In the foregoing the ratio in depths of one to two is taken to simplify the discussion. Any other relative depths could be taken, and it would be found that starting with any given beam having 1¼% of steel the strength of a deeper beam of the same width with the same steel rods, placed ⅛ of the depth from the bottom, will be directly as the depths.

DESIGN OF COLUMN AND WALL FOOTINGS.—In proportioning concrete-steel footings the same principles of design hold; the beam, however, is a cantilever and not a simple beam.

Given a wall footing with a projection p and an upward pressure of the soil of S tons per square foot; in order to have shearing area at the edge of wall to take the upward pressure on the projection p, at 40 lbs. per sq. in. on the gross area, we have

$$40\ h = \frac{2{,}000\ S}{144} \times p, \text{ or}$$

$$h = .35\ p\ S. \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

That is, for every ton of soil pressure per square foot there must be a height h of 0.35 times p. Square rods seem to be the most suitable for footings. For the size of rod, in order to have 50 diameters of the rod in concrete at the point of maximum stress it is necessary to use rods of a diameter not greater than 1/50 of the projection p. The curve of moments and of stress in the rods is a parabola which lies at all points within the straight line representing the adhesion or gripping of the rod by the concrete. Hence p need be no greater than 50 d. Assume that

$$p = 50\ d. \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

and that the stress on steel is 12,500 lbs. per sq. in. The amount of stress on the concrete will be the same as that on the steel, hence we may write for the allowed moment on a section x inches in width and h inches in depth,

$$M = 12{,}500\ d^2 \times \frac{17}{24} h = 8{,}854\ d^2\ h.$$

But $h = .35\ p\ S$, whence $M = 3{,}099\ p\ d^2\ S$ inch-lbs.

From the upward pressure of S tons per sq. ft. we have

$$M = \frac{2{,}000\ S\ x}{144} \times \frac{p^2}{2} = 6.94\ S\ p^2\ x.$$

Equating these two values of M and using for p its value 50 d we have

$$x = 8.93\ d, \text{ or say } 9\ d. \quad \ldots\ldots\ldots\ldots (3)$$

Hence for any upward pressure the same rods would be used, having a diameter 1/50 of p and spaced 9 times their diameter apart. Only the height h would vary for different earth pressures, as per equation (1).

The foregoing does not take into account the stress on the concrete, but we have seen that when the steel does not exceed 1¼% of the concrete the stress in the concrete will not be excessive. When the steel in this footing = 1¼% of the concrete, $h = 8.89\ d$ or $8.89 \times \frac{p}{50} = .178\ p$. This would mean an earth pressure of only about a half a ton per square foot. Hence for all practicable earth pressures the amount of concrete is ample.

In square footings for columns the corners will have a projection 1.4 times that of the sides. The height h should be made 1.4 times that obtained by equation (1) using the projection at the side. Some rods should be laid diagonally, as shown in Fig. 3.

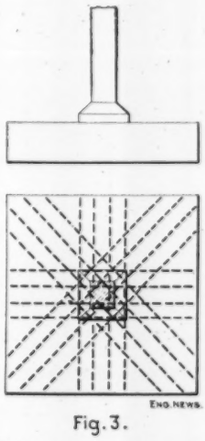


Fig. 3.

If cinder concrete be used in the wall footing, at 25 lbs. per sq. in. shear on gross area, we have

$$p = 83\ d. \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$h = .56\ S\ p. \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$x = 8.5\ d. \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

For a plain concrete footing in stone concrete, allowing 40 lbs. per sq. in. as safe modulus of transverse strength we have for the bending moment under edge of wall

$$\frac{2{,}000\ S}{144} \times \frac{p^2}{2}$$

and for the resisting moment $\frac{40\ h^2}{6}$, both on a rectangle h inches deep and one inch wide. Equating these we find the following to be very nearly true:

$$S\ p^2 = h^2. \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

For a plain cinder concrete footing at 20 lbs. per sq. in. safe modulus of transverse strength, similarly we find

$$2\ S\ p^2 = h^2. \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

By the foregoing we may obtain the relative cost of footings plain and reinforced. Thus at two tons per sq. ft. earth pressure, by eq. (1) $h = .7\ p$ (reinforced) and by eq. (7), $h = 1.4\ p$ (plain). By comparing the cost of the steel reinforcement with that of the additional excavation and concrete the relative costs of the plain and reinforced footings may be found.

DESIGN OF COLUMNS.—In the design of concrete columns reinforced with steel it is essential to keep in mind the rational use of steel as a reinforcement in concrete, namely, to take tensile stresses. When a prism is compressed longitudinally, its diameter is increased, hence the outer fibers are put under annular tension. Hoops or spirals bedded near the surface of a circular column will resist this tension and relieve the concrete. Hoops would have to be welded into solid rings to be of use, but a spiral may be used in long lengths. M. Considère in a series of tests on hooped concrete columns found that they exhibited great strength against compressive loads. They also showed regularity in the matter of failure. Where a plain concrete column would break suddenly without warning, a hooped column would hold together after cracks had shown partial failure to have occurred. These are desirable qualities in any kind of construction. Columns reinforced with longitudinal rods only did not show much, if any, advantage over plain columns. Longitudinal rods, however, are very useful in connection with a coil to space the loops and to tie the concrete together longitudinally, also to assist in resisting flexure in the column due to eccentric or horizontal loads.

It may be shown by a little computation that the area of metal required at a given unit stress to contain the liquid contents of a cylinder by resisting the bursting pressure is double that required to support the same load if the cylinder acts as a column. M. Considère found by the formulas for earth pressures that a shell filled with sand is 2.4 times as effective to sustain the load as it would be in the form of a column, at the same unit stress, and his experiments along that line confirm his calculations. This would mean that the lateral pressure of the sand is $\frac{1}{4.8}$ times its longitudinal pressure. If, then, we treat the disintegrated concrete, at failure, as a substance whose pressure against the spirals is $\frac{1}{4.8}$ times that of a liquid confined in a cylinder, we may arrive at the tension on a spiral. In the tests above referred to some very high unit loads were shown at failure, while some of the tests failed between two and three thousand pounds per square inch. While the hoops or coils may hold the disintegrated concrete together and show high unit loads before ultimate failure, the nature of the material as commercially made does not justify a higher safe unit load than about 550 lbs. per sq. in. The concrete between the spirals is in no better shape to resist compression than that in a beam. Using this unit load in short columns (under ten diameters in length) we have for our effective liquid pressure $550 \div 4.8 = 115$ lbs. per sq. in.

Let D = outside diameter of column and $\frac{1}{8}$ D = pitch of coil, in inches.

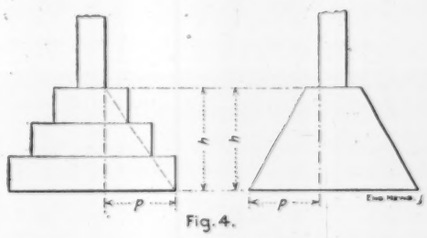


Fig. 4.

$$\text{The tension on a coil} = 115 \times \frac{D}{2} \times \frac{1}{8} D = 7.2\ D.$$

Allowing 12,500 lbs. per sq. in. on the steel we have for square rods of diameter d inches

$$12{,}500\ d^2 = 7.2\ D^2.$$

$$\text{Or } d = \frac{1}{42} D \text{ nearly.}$$

If the diameter of coil be made ⅞ that of the column and that of the steel be made 1/50 of the same the stress on steel will be practically 12,500 lbs. per sq. in.

It is recommended that round or octagonal columns be used and that the full area of the

circle be included as taking the load, also that square rods be used having a diameter one-fortieth that of the column in a coil with a pitch one-eighth that of the column. Where 1/40 D would give an odd figure the nearest sixteenth or eighth may be used and the pitch made five times as great.

In proportioning the longitudinal rods we may, in order to establish a rule for their size, follow the method employed by Marsh in "Reinforced Concrete" and allow them to take the outward force of the concrete between the spirals. If we assume eight square rods placed vertically inside of the coil, their clear span is $\frac{D}{8} - \frac{D}{40} = \frac{D}{10}$. The outward force from the 115 lbs. per sq. in. of assumed liquid pressure is $115 \times \pi D \div 8$ per inch. Being fixed ended their moment is $wl^2 \div 12$ or $\frac{115 \pi D}{8} \times \frac{D^2}{100} \times \frac{1}{12}$.

Equating this to 12,500 $d'^3 \div 6$, the resisting moment of square rods of a diameter d', we obtain

$$d' = \frac{D}{38}.$$

This is close to one-fortieth of the column diameter; hence eight rods of the same diameter as that used in the coil may be placed on the inside of the coil and wired to the same. Where a coil ends the next should lap not less than half a coil, which would be about 55 diameters.

For columns more than ten diameters in length it is recommended that smaller unit loads be used, down to a minimum of 370 lbs. per sq. in. at 25 diameters. They should not be any more slender than one-twenty-fifth of the length. Between 10 and 25 diameters the allowed unit pressure would be found by the following formula:

$$p = 670 - 12 \frac{l}{D}$$

where p = pressure per square inch,
l = length in inches,
D = diameter in inches.

It is recommended that the same reinforcement be used in all columns of a given diameter, so that flexure will be taken care of in long columns.

A CABLE INCLINE RAILWAY WITH ENDLESS CABLE.

A novel system of cable railway was built in 1905 at Nancy, France, to afford access to a suburb and pleasure resort on a plateau above the city. Cable inclines have been used in many cases in Europe, as well as in this country, but have usually two cars at opposite ends of a cable, one car ascending as the other descends. This alternative movement does not give much flexibility to accommodate variations in traffic, and at busy seasons crowds collect faster than the cars can handle them. In the Bernardet system adopted at Nancy, there is an endless cable running continuously and small cars can be attached or detached as required. Each car carries six passengers, and when running at intervals of 20 seconds they can handle 1,080 persons per hour.

The two stations are 755 ft. apart, with a difference in elevation of 157 ft., the grades being from 16 to 20%. The two tracks have a gage of 30 ins. and are spaced 6 ft. 6 ins. c. to c. The rails weigh 20 lbs. per yd. and are laid on longitudinal timbers 7¼ ins. high and 5 ins. wide. These rest on cross ties 6.56 ft. apart, to which they are secured by long bolts which are outside of the stringers and have the nuts screwed upon flat plates laid across the stringers. Laid upon the ties is a 15-lb. rail for the grooved wheels of the saddles which are attached to and support the cable. The cable, Fig. 1, is formed by two steel cables 1 in. diameter, one above the other, and connected by the traveling saddles with rollers and by intermediate blocks alternating with the saddles; these are spaced about 5 ft. apart, and are shown in Fig. 1. Both the saddles A and blocks B engage with the driving pulleys, but only the former are used for the attachment of cars. The cables are thus practically parallel with the rails, and the height of the attachment to the cars remains uniform. With the cable thus supported definitely at 10-ft. intervals the sag is only that of a 10-ft length, and a counterweight of 2,640 lbs. attached to the tail of the tension carriage gives sufficient tension to keep the cable rigid. The cable travels at a speed of 200 ft. per min.

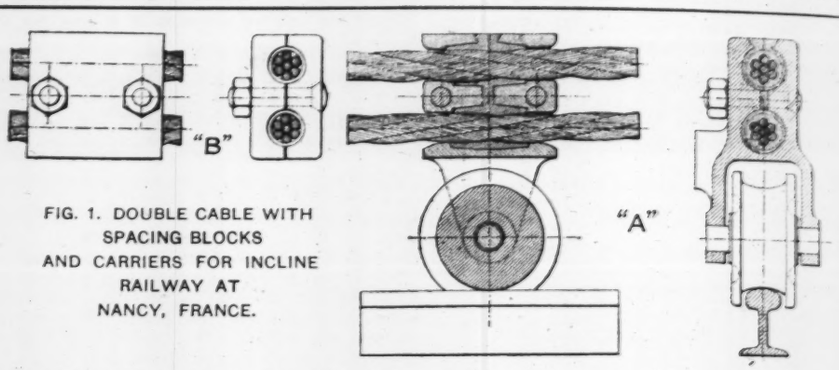


FIG. 1. DOUBLE CABLE WITH SPACING BLOCKS AND CARRIERS FOR INCLINE RAILWAY AT NANCY, FRANCE.

The power station is at the upper end, and has an electric motor driving a train of gearing which ends with a bevel pinion meshing with a bevel spur wheel on the upper face of the cable driving pulley, which is 6 ft. 6 ins. diameter. The motor is so arranged as to act as a generator when the descending load exceeds the ascending load. There is an automatic electric brake between the motor and the driving wheel, which is applied in case of failure of the current. There is also a powerful band brake on the driving wheel, operated by hand. The operator is stationed on the upper floor, where he has a good view of the line.

The cars, Fig. 2, are open, and have two transverse seats, back to back, each seat being for three persons. The seats are arranged to give passengers a comfortable position on the grades. The car is attached to the cable by a coupling hook engaging with the roller saddle and operated by a vertical rod on the car. To start the car, the attendant at the station throws a lever which drops the hook A into position; at the arrival station, an inclined plane automatically raises the hook clear of the cable. Automatic safety devices are applied to the cars; should the car become detached from the cable, pawls engage with ratchet wheels on each of the axles, thus stopping the wheels, while a short, heavy bar on each side drops to a vertical position, so as to come in contact with stops attached to the rail stringers. These devices are simply held out of operation by a spring attached to the grip; to prevent their operation. However, at stations, when the grip is released, there is an automatic latch operated by gravity by means of a ball rolling in a groove, as shown at B in Fig. 2. When the car is on the incline the ball is in one position and the safety devices are free to act; when the car runs on the level at the station the ball moves over and operates the latch. There are 20 cars in all.

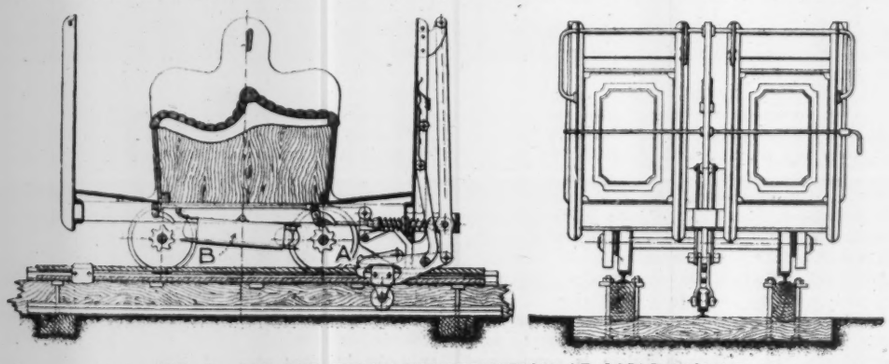


FIG. 2. CAR AND TRACK CONSTRUCTION OF CABLE INCLINE.

At the upper end of the line is a car shed and repair shop, with inspection pit; it has two tracks, one of which extends to the main track, connected with it at the intersection by a turntable. At the lower end is a shed for eight cars, which are used as required. A curious feature is that the cars do not pass around curves at the ends of the line, but are shifted laterally from one track to the other by electric transfer tables. The table, Fig. 3, has endless chains of bars 26 ins. long, carrying plates which form a platform for the cars. The chains pass over hexagonal driving wheels, and run at a speed of 60 ft. per min., but have an intermittent travel of only 6 ft. 6 ins. (the distance c. to c. of tracks) at each movement. When the empty car is ready, the attendant pulls a lever which throws the table gear in contact with the driving gear, which is in continuous motion. The gear is then automatically disconnected when the table has made its travel of 6 ft. 6 ins. (or three links).

The total cost of the line was about $12,000, including 20 cars. Our information and illustrations are from an article in the "Revue Generale des Chemins de Fer."

A UNIVERSAL DICTIONARY OF MECHANICAL DRAWING.*

By George H. Follows.†

Part X.—Checking.

147. Before drawings are permitted to go to the shop they should be systematically checked. In large drafting rooms it is now quite generally the practice to have certain men do nothing else but check the work of the draftsmen. This checking is of vital importance; mistakes are not mistakes until after they have eluded the checker's eye. A drawing, like a machine or other manufactured product, is not ready for use until it has been officially inspected, and perhaps tested.

148. The following suggestions are intended as a help to systematic checking. Each feature should be taken up separately and, if possible, each phase of the work completed before passing on to the next.

1. Put yourself in the position of those who are to *read* the drawing and find out if it is easy to read and tells a straight story. Always do this before checking any individual features; in other words, before you have had time to become accustomed to the contents.

2. See that each piece is correctly illustrated

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†The Park View, East Liberty, Pittsburg Pa.

that all necessary views are shown, but none are not necessary.

3. Check all the dimensions by scaling, and, ere advisable, by calculation also.

4. See that dimensions for the shop are given required by the shop, that is, that the shop is left to do any adding or subtracting in order get a needed dimension.

5. Go over each piece and see that finishes are operly specified.

6. See that every specification of material is rrect and that all necessary ones are given.

7. Look out for "interferences." This means eck each detail with the parts that will be adcent to it in the assembled machine and see at proper clearances have been allowed.

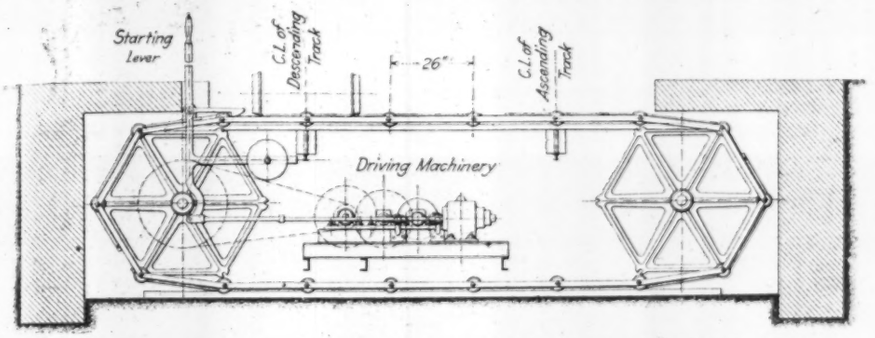


FIG. 3. ENDLESS-BELT TRANSFER TABLE FOR SHIFTING CARS OF CABLE INCLINE.

8. When checking for clearances in connection with a mechanical movement, lay out the movement to scale, figure the principal angles of motion and see that proper clearances are maintained in all positions.

9. See that all the small details, as screws, bolts, pins, keys, rivets, etc., are standard and that where possible stock sizes have been used.

10. Check every feature of the record strip.

11. Review the drawing in its entirety in connection with any points that have suggested themselves during the above checking.

12. Bearing in mind the value of explanatory notes, do not fail to add such notes as your experience tells you will increase the efficiency of the drawing.

TEST OF A CURTIS MARINE TURBINE.*

By W. G. Diman.†

By request of the Fore River Shipbuilding Company, a series of tests were made at the works of the E. W. Bliss Company, Brooklyn, N. Y., Nov. 28 and 29, 1905, by a Board appointed by the Secretary of the Navy, of which Commander A. B. Canaga, U. S. N., was senior member, to determine the amount of steam used per brake horsepower by an experimental Curtis marine turbine at different revolutions per minute, and with steam varying in quality from saturated to about 50° F. superheat. The tests were made at revolutions varying from 600 to 900, and with a brake horse-power of 1,000 to 1,250, which is only the conditions of the higher speeds. In naval practice the speed is a variable quantity, and only during short intervals is full power attained.

The turbine is of the Curtis marine pattern, built for experimental purposes, but embodying the essentials of such a turbine as is now building by the Fore River Shipbuilding Company for marine use. There are two shells connected by piping. The first shell contains four "go-ahead" stages, and the second shell three "go-ahead" stages and one backing stage. The "go-ahead" stages each consist of three rotors with two sets of fixed guide blades, intermediate and fixed to the casing. The backing stage consists of five rotors with four fixed guide blades. All rotors are 54 ins. in diameter measured at middle of radial length of blades. The blades of the rotors are continuous around the whole periphery and vary in pitch and length according to the degree of expansion necessary at the position they occupy in sequence. The fixed guide blades vary in length of arc around the periphery, as well as in pitch and blade length in the same manner as the rotors. Each stage is separated from the next stage by a diaphragm forming part of the casing. The shaft fits neatly through holes in these diaphragms with only sufficient clearance for water packing. The last "go-ahead" stage and the backing stage are in the exhaust shell; there was no steam connection to the latter stage, so no experiments on backing were made.

The course of the steam was as follows: From the boiler to the throttle it passed through a 6-in. pipe, from the throttle it passed through a 4½-in. opening to the steam chest. From the steam chest the steam was admitted to the nozzles of the first stage, these nozzles being eight in number, each controlled by a valve. Only six of these nozzles were in use during the test. At the second stage there are sixteen nozzles, nine of which are controlled by valves; at the third stage there are sixteen nozzles, eight of which are controlled by valves; at the fourth stage, sixteen nozzles, eight controlled by valves; at the fifth stage, twenty-four nozzles, ten of which are controlled by valves; at the sixth stage, thirty nozzles, nine of which are controlled by valves; at the seventh stage, twenty-seven nozzles, twenty of which are controlled by ten valves. The pressures in the various stages are regulated by means of the valves at the nozzles. Each stage was drained into a small reservoir placed in a pit below the shell. As the pressures in the last four stages were below that of the atmosphere, each of these reservoirs were provided with two valves, one between it and the shell, and one between it and the drain pipe, so that by opening the upper valve the water collected in the reservoir, then closing the upper valve and opening the lower valve it flowed by gravity into a drain pipe leading to an adjacent pit containing a tank and scales for weighing.

The bearings of the turbine shaft all had forced lubrication, and on account of the small diameter of the shaft it was found necessary to locate a bearing inside each shell. This would not be the case in a turbine built for actual use, where the size of the shaft would be increased. Some of the oil from these bearings entered the steam spaces and was run off and weighed with the drip water. The nozzles of the first stage were so made that the steam was expanded to increase its velocity, the nozzles of all other stages were of the non-expansion type.

The turbine shaft extended beyond the exhaust shell and was fitted with two water brakes for measuring the horse-power. The casings enclosing the disks of the water brake were accurately balanced on knife edges. The casings were fitted with pipes and funnels through which they received water from pipes fitted above them. Below the casings there was a large pipe and valve, so that by opening or closing the valve the amount of water in the casings was regulated and the number of revolutions of the turbine could be accurately adjusted.

Steam was supplied by two Stirling boilers, each having a grate surface of 67.5 sq. ft., and heating surface of 2,523 sq. ft. The draft was furnished by a blower working on the induction system. The pressure carried at the boiler was 265 lbs. gage. The feed water was supplied by a duplex plunger pump of the Blake pattern, and was heated to about 200° F. before entering the boiler by a 600-HP. Cochran feed heater using exhaust obtained from the auxiliaries. There was a superheater of the Babcock & Wilcox type using oil as fuel. This superheater was entirely separate from the boiler, and was so arranged that the steam could be sent through it or by-passed at will. The steam passed from the exhaust casing through a wide cast-iron nozzle to the top of a Wheeler condenser having a cooling surface of 2,700 sq. ft.

The air pump was a twin, vertical, single-acting, valveless suction air pump of the Edwards patent. The desired vacuum of 28 ins. was easily maintained, and was regulated by means of an air valve so as to keep it uniform at all times.

Attention is particularly called to the accompanying table, showing the average results of each test at different revolutions and the average steam pressure, vacuum, and water rate for each series of tests with revolutions varying from 600 to 900. The table shows how slight the variation in water rate was for all tests under the same conditions; i. e., the same degree of superheat. This, however, should be expected, as the initial and final pressures were kept constant and the opening of the nozzle valves on the first stage was always the same. The slight variation in the water rate was probably more affected by the method of handling the drip than by any inherent condition of the turbine.

*Extracts from a paper in the "Journal of the American Society of Naval Engineers," for February.
†Ensign U. S. N.

AVERAGES OF TESTS OF CURTIS EXPERIMENTAL MARINE TURBINE.

Duration of Tests, Minutes	Pressure in steam chest. Gage.	Vacuum in exhaust stage. (Corrected) inches.	Degrees of superheat.	Revolutions per minute.	Brake horsepower.	Water per B. H. P. per hour.	Drips.
30?	245	28	4.0	902	1,232.7	14.11	All Drips closed during test and shells drained at end of test.
42	245	28	4.8	698	1,136.6	14.71	
	245	28	10.2	598	1,053.0	16.35	
20	245	28	8.5+	900.8	1,283.8	13.23	Drips all open.
14	245	28	4.1	593—	1,065.0	16.2—	
54	250	28	Per cent of moisture = .801 of 1 per cent.	698.5	1,168.5	14.90	Drips all open.
18	245	28	44.9	901	1,295.8	12.92	Drips all closed during test.
12	245	28	46.6	695.8	1,167.5	14.38	Shells drained at end of test.
18	245	28	50.5	598.9	1,077.1	15.55	
31	245	28	8.5	893.8	1,273.4	13.4	Drips all open.
24	245	28	8.3	798.2	1,130.4	13.9	
30	245	28	11.5	699.9	1,167.0	14.7	
30	245	28	9.5	600.6	1,081.1	15.9	
24	245	28	10.2	808	1,244.6	14.03	All Drips closed except on reversing stage, other shells drained at end of test.
26	245	28	8.1	802	1,196.6	14.45	
25	245	28	7.8	696.5	1,162.3	14.69	
36	245	28	8.1	597.1	1,055.4	16.43	
18	245	27.89	8.5	Turbine locked to Brake.	.....	.....	Drips open.

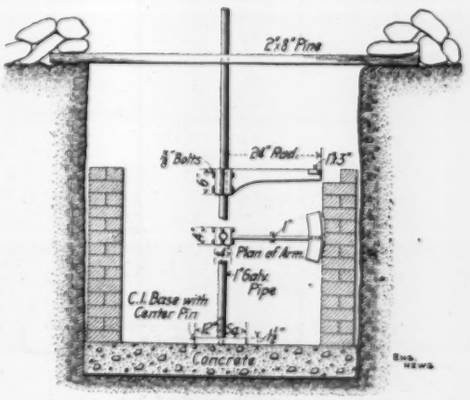
A SIMPLE DEVICE FOR USE IN BUILDING CIRCULAR MANHOLES.

By Elmer E. Barnard,* Jun. Am. Soc. C. E.

The enclosed sketch shows a simple but very useful tool for building circular manholes. It has been used in our sewer department for about a year, and it certainly has been a time-saver. Only some ten minutes is required to set it ready for work, and the class of work resulting from its use is far superior to that which was being done before the writer introduced it into the department.

[The arm might be made adjustable, by a telescopic or other arrangement, for use in drawing in the upper courses in the contracted portion of the manholes.—Ed.]

*Assistant City Engineer, Lynchburg, Va.



A Simple Device for Use in Building Circular Manholes.

INTERESTING CONSTRUCTION AND ERECTION DETAILS IN A REINFORCED CONCRETE FACTORY.

An interesting detail of reinforced concrete wall and metal frame window construction was recently employed in constructing the six-story and basement factory of the Fred. Gretsch Realty Co., of Brooklyn, N. Y. The building has a frontage on South Fifth St. of 72 ft. and a depth of 125 ft. Excavation was begun July 4, 1905, and the footings were all in Aug. 25, there being several weeks' delay due to the necessity of carrying down to required depth the footings of adjoining properties. The form work for the first floor was well under way by Sept. 1, and the six floors and roof were in place complete Dec. 1, making a record of 3½ stories per month. The building was completely enclosed by Jan. 1, 1906; the elevator was in operation by Jan. 15 and all floors were occupied by Feb. 1.

Construction work was carried on as a skeleton design, the interior and wall columns carrying all loads; that is the floors and columns were erected tier on tier, the curtain walls following. This method made rapid erection possible, permitting concreting of walls when floor work could not proceed on account of bad weather (the cement finish being laid monolithic with the floor construction). A reduced thickness of walls was also possible. The basement curtain walls are 12 ins. in thickness and where acting as retaining walls are reinforced with ½-in. square twisted rods 6 ins. on centers at the bottom, the spacing widening as the top is reached. Curtain walls in all other stories are 8 ins. in thickness, reinforced with ⅜-in. bars 2 ft. on centers. Spread pier footings were used, reinforced with twisted rods. The inverted girder type of footing was used in cases where the building line coincided with adjoining property. The columns are square in section, rounded at the corners with a core molding. In the lower stories the concrete in the columns is stressed to 800 lbs. per sq. in., all floors

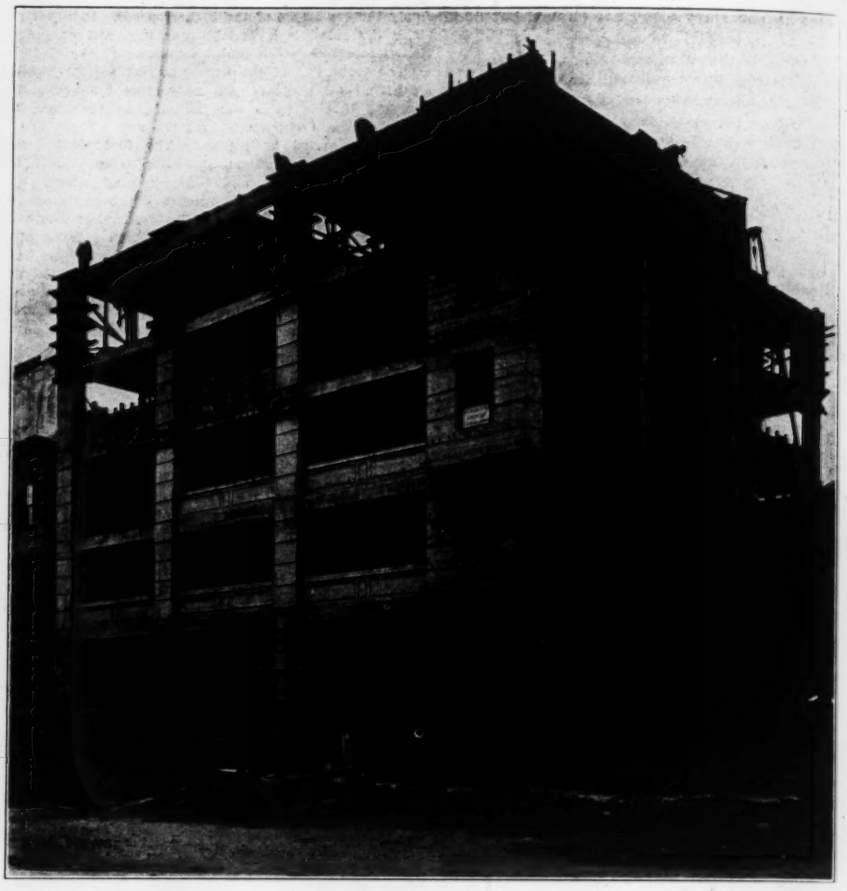


FIG. 1. VIEW OF REINFORCED CONCRETE FACTORY BUILDING, SHOWING PROGRESSIVE CONSTRUCTION OF FRAMEWORK AND WALLS.

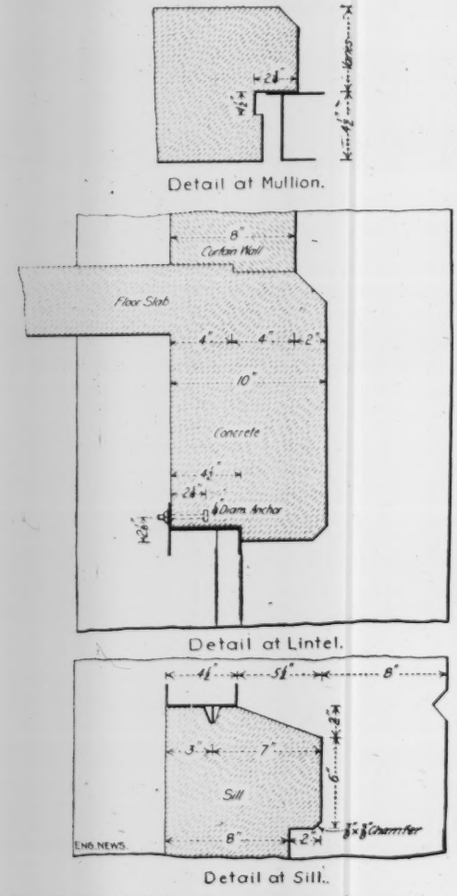


Fig. 2. Detail of Steel Frame Window Construction in Concrete Walls.

assumed as loaded. Spiral reinforcement formed of ¼-in diameter wire with a pitch of 4 ins. to the foot was placed in these columns with four 1¼-in. diameter round rods, connected at each floor with threaded couplings. The wall columns are in no case stressed above 500 lbs. per sq. in., and the reinforcement consists of vertical twisted rods and hoops ⁵/₁₆-in. steel, 12 ins. on centers.

The large window areas and natural light is a noteworthy feature of the building. On the south, east and north elevations there is a maximum window area; two frames totally filling the space between wall columns, a distance of 16 to 18 ft. with a 12 × 12 in. concrete mullion separating the two. The frame rests upon a curtain wall 3 ft. in height having a cement finish sill. The method of building the frame securely in place is as follows: In the wall columns and cement sill, Fig. 2, a slot is formed; when the frame is to be placed the slot in the sill is filled with grout; a fin on the bottom of the frame sets into this. Corresponding fins protrude from the sides of the frame. A recess in the column admits these fins; another fin with holes in it is provided on the top of the frame; this fin is bolted to the beam or lintel by means of ¼-in. bolts, previously left in the lintel for this purpose. A board is now braced to the frame and column and the recess left for the side fin is poured with grout which is keyed in by the bevel shape of the recess. The mullion is poured after the frames are set, being tied into the sill and lintel by means of rods left protruding from the above. The above method has given entire satisfaction, making the frames absolutely weather tight. On the west elevation there is 30% window area. In this case the window frame is placed in the wall form, as is customary, and the concrete poured around it; great care is exercised to secure a weather-tight joint between concrete and frame.

All concrete came up smooth without voids or imperfections in the exterior walls and columns; in order, however, to bring all concrete to a uniform color the exterior surfaces were given a brush finish of a special light colored cement mixed with white sand.

Mr. Benj. Finkensieper was the architect of the building and the work was designed and erected by the Turner Construction Co., of New York City.

THE OZONE PLANT FOR TREATING A PART OF THE WATER SUPPLY OF WIESBADEN, GERMANY.

Not long ago one of our foreign exchanges reported that the ozone plant designed to treat a portion of the water supply of Wiesbaden had been abandoned. This, as is shown further on, proves to be incorrect, the plant merely being held in reserve, just as it was some two years ago when visited by a member of our editorial staff. (See Eng. News, Jan.-June, 1904, p. 535.) In response to our request Mr. Halbertsma, Director of the Wiesbaden works, has sent the following information in regard to the ozone plant, which in connection with the editorial correspondence already mentioned gives a clear idea of the whole situation:

[Translation.]

In regard to our ozonizing plant, I am able to tell you that since you were present with us nothing new has developed. The plant is still in existence, and we do not at all consider at present having the same dismantled. It is operated each month, during one day, so as to keep it in running order and to preserve it as a reserve supply.

The Schierstein water-works [gang wells, near the Rhine] is at present only used as a reserve; and as we had a plentiful supply of water in our shaft [mountain tunnel] which has accumulated during the last winter (which proved to be an exceptionally wet one), we shall therefore not be compelled to have recourse to the Schierstein water-works. The last few years have also shown that the Schierstein plant will furnish a first-rate potable water without being ozonized, just as soon as we shall have our plant for the removal of iron in operation—that is to say, provided the surrounding land is not inundated by the Rhine River; when that event takes place, the number of bacteria increases a trifle, and we then have the choice either to cease drawing water from Schierstein or to operate the ozonizing plant connected

with it. As the ozonizing process is rather an expensive one, and is made so principally by the many bacteriological tests which are necessary for the control of the proper working of the plant, we will presumably not make use of the ozonizing plant at high water, but will cease drawing water from Schierstein, and simply draw our supply from the storage at the rear of our shafts. At the same time, the ozonizing plant might prove to us of great value when, for instance, during a dry summer, the supply in the shafts [in the mountain tunnels] is nearly exhausted and the country surrounding the wells has been inundated by the Rhine water. In this case, it would still be possible to supply the city of Wiesbaden in sufficient quantity an almost hygienically perfect potable water.

H. P. M. Halbertsma,
Director City Water, Gas and Electric Works.

Wiesbaden, Germany, May 16, 1906.

THE EFFICIENCY OF AUTOMATIC STOPS IN SIGNAL APPARATUS.

The use of apparatus for automatically setting the brakes of a train which is allowed to pass a signal at the "stop" position is now generally recognized as an almost essential auxiliary to the signal system of city railways operated by electric trains at close intervals, such as the various modern underground and elevated railways of American and European cities. Cases have occurred, however, in which trains have passed "stop" signals and have not been stopped by the automatic application of the brakes, and these point to the necessity of constant and rigid inspection to ensure that the apparatus is maintained in working condition. A case in point is a rear collision which occurred on an open-air portion of the Metropolitan District Ry., of London, England. A train of seven cars (three of which were motor cars) ran into the rear of a three-car train (with two motor cars), having passed an automatic "stop" signal equipped with an automatic stop device, which should come in contact with a trigger on the car so as to open the valve of the Westinghouse brake system. The line has track circuits and is equipped with the Westinghouse electro-pneumatic signal system. The accident occurred during a fog, and there was some dispute as to the position of the signal, but the government inspector who investigated the accident concluded that the signal was undoubtedly at the "stop" position. The inspector therefore turned his attention to the failure of the automatic brake-setting device to perform its function, and we give the following statement from his report upon this contributing feature of the accident:

The evidence of Mr. Jackson, Assistant Signal Engineer, and Mr. Agnew, Rolling Stock Superintendent, proves that the trigger must have struck the train stop with the signal at danger. The former gaged the position of the stop shortly after the collision and found it correct; the latter took the train over the same track and found the trigger came in contact with the stop, and was thereby moved round until it fouled some of the brake rigging. The movement, however, was not in his opinion sufficient to open fully the air-brake valve. He accounts for this by the fact that the trigger, or its attachment, was twisted on its axis and, owing to the small amount of clearance allowed, free movement of the trigger was interfered with by the brake rigging.

There is no evidence to show how or when the brake trigger became twisted. If it were twisted before the train started on its journey the car examiners would have discovered the defect if they had tested its action properly, instead of merely gaging its vertical and horizontal distance from the rail. It appears, therefore, to be probable that when the train passed the automatic signal immediately prior to the collision, the brake trigger struck the train stop, which was in the proper danger position, and was thereby moved, though not sufficiently to apply the continuous brake forcibly enough to bring the train to a standstill. It is quite possible that the air valve was partially opened, but as the motorman was occasionally applying the brake to reduce the speed of the train, and maintaining the pressure by keeping the air pump going, it is unlikely that he would notice any small automatic application of the brake caused by an incomplete movement of the brake trigger.

On a railway where, to obtain a frequent and fast service of trains, block sections are comparatively short, and distant signals have practically been dispensed with, the efficiency of the train tripping apparatus is of great importance. Further than this, in foggy weather or failing snow the arrangements must be absolutely reliable if fogmen and fog signalling are to be dispensed with. The existing apparatus and arrangements, as this case proves, call for improvement in several respects:

(1) The triggers are mounted on the side frames of the car, and are thereby liable to movements caused by swing of the frames, or action of the springs; direct attachment to the axles is desirable. (2) Only one trigger (on the leading car) on a moving train is in the striking position. The present case points to the advisability of having a second trigger available in case of failure of the first. Both triggers might be attached to one car. (3) At all terminals, and other places where brakes are tested, car examiners (as well as the motorman or front conductor of a train) should actually test the movement of the striking triggers by moving them until the air valves are fully open.

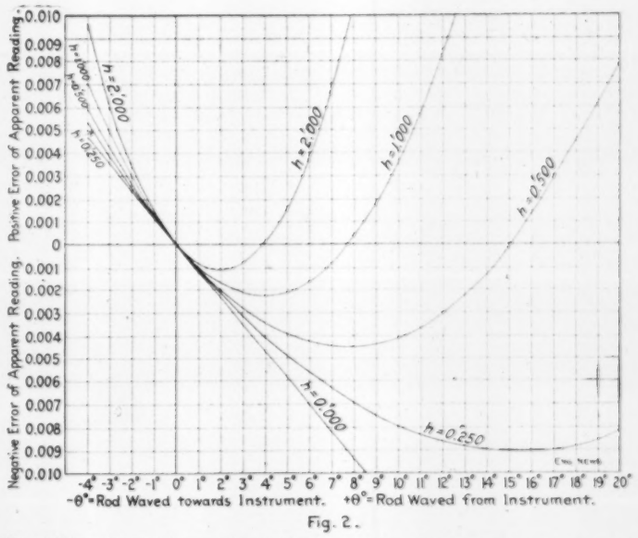


Fig. 2.

AN ERROR IN LEVELING CAUSED BY WAVING THE LEVELING ROD.

By A. H. Horton.*

In differential leveling, when no rod level is used by the rodman, it is generally the custom to have the rodman wave the rod slightly away from and towards the instrument; the levelman taking the minimum reading of the rod as the true rod reading. The writer has noticed during his work that for short rod readings, such as ½ ft., holding the rod out of plumb, away from the instrument, makes the reading smaller instead of larger. This is due to the fact that the graduated face of the rod is not directly over

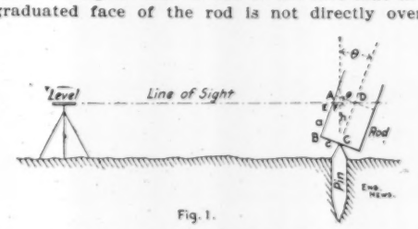


Fig. 1.

the point of support, and holding the rod out of plumb away from the instrument causes the graduated face to be raised. The results of a study of this error follows. Mr. Louis Ross† derived the following mathematical expression for the error:

In Fig. 1, let L represent the level, s the horizontal line of sight striking the rod at the point E, the rod being out of plumb by an angle θ.

Let BE = a = apparent rod reading.

CF = h = true rod reading,

and ADE = FCD = θ,

also c = ½ width of rod = BC,

and e = positive error = a — h.

Then

$$e = \frac{h(1 - \cos\theta) - c\sin\theta}{\cos\theta} = h\,\text{exsec}\,\theta - c\tan\theta$$

The curves in Fig. 2 have been prepared from this formula to show the effect of different values of h and θ upon the error caused by waving the ordinary Philadelphia rod of a width of 1.6 ins.

A study of the curves shows that:

(1) The shortest apparent reading occurs when the rod is not vertical, but inclined from the instrument.

(2) The inclination which makes the reading a minimum, or the error a maximum varies for different rod readings, the relation being $\theta = \frac{4}{h}$ where θ = inclination, in degrees away from the level, and h = the true rod reading in feet.

Thus for a height of 2 ft., the minimum reading will occur when the rod is inclined 2° away from the level.

(3) The difference between the minimum and the true rod reading also varies with the height of the rod reading, their relation being

$$e_{max.} = \frac{1}{450\,h}$$

Thus for a height of 0.5 ft. the error caused by taking the smallest reading is $\frac{1}{450 \times 0.5} =$ 0.0044 ft. This will occur when the rod is inclined away from the level by an angle $= \frac{4}{h} = \frac{4}{½} = 8°$.

(4) In order that the rod should read true it must be held either vertically or else at some particular angle depending on the rod reading, and expressed by the equation $\theta = \frac{8}{h}$.

Thus if the height is 1 ft. the rod will read true when held either vertically or inclined $\frac{8}{1} =$ 8° away from the level. Any other inclination causes the reading to be in error.

(5) For large rod readings, say over 2 ft., this error is negligible, being less than 0.001 ft.

Fig. 3.

(6) For any reading less than 2 ft. it is probably more accurate to have the rodman plumb the rod rather than wave it.

(7) The bottom of level rods should be made so that the point of support should be as nearly as possible directly underneath the graduated face. The form shown in Fig. 3 is suggested.

THE RAILWAY MILEAGE OF THE WORLD at the end of 1904 aggregated about 550,735 miles, according to the statistics of the "Archiv fur Eisenbahnwesens." This is distributed as follows: North America, 249,717 miles (213,904 miles of which were in the United States); Europe, 189,774 miles; Asia, 47,974; South America, 30,258; Australia, 16,810; Africa, 16,202 miles. This is an increase of about 3% over 1903, and it is estimated that at the present time there are about 575,000 miles of railway in operation throughout the world. The average cost per mile is about $112,777 in Europe, $50,963 in the United States, and $57,991 for the rest of the world. The greatest development of mileage of 1904 was in North and South America, as follows: United States, 5,600; Mexico, 1,720; Argentine Republic, 1,610; Brazil, 1,040. The total cost of the entire railway system of the world is put at $42,000,000,000, 50% of which is for railways in Europe.

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AN IMPORTANT STREET IMPROVEMENT WITH STREET RAILWAY SUBWAY AT LONDON, ENGLAND.

The largest and most important street improvement which has been carried out in London, England, for many years is the construction of a broad thoroughfare running north from the Strand and connecting that crowded street with other parallel east and west streets. Up to this time the only communication was by narrow and irregular streets, to find a route through which was a difficult task for anybody not possessed of the geographical instinct of the London cabman. Furthermore the district between these streets was largely of the slum character, unsanitary and in parts dangerous. The street is only about 4,200 ft. long, but it is 100 ft. wide, and with the spurs connecting to intersected streets and the character of the buildings being erected it will create a new business district. Part of its length includes the widening of old streets, but the other part cuts directly through what was a maze of streets, courts and tenements. At the southern end it does not enter directly into the Strand, which would make a serious eddying of traffic in that congested thoroughfare. Instead, it branches off to form a crescent, each horn of which is 100 ft. wide, entering the Strand at points about 800 ft. apart; two new cross streets through the segmental block thus formed serve to still further distribute the traffic.

A street of this kind has been proposed at intervals during the past 60 years, and began to be seriously considered some ten years ago. In 1898 the Improvement Committee, after careful consideration of various schemes, adopted the one now completed, which had been submitted in 1892 and again in 1895, but afterwards modified in accordance with suggestions made by the Royal Institute of British Architects. The original plan was for a width of 90 ft., but it was found that exactly the same properties would have to be acquired as for a width of 100 ft.; there would, of course, be a smaller area of surplus land, but as the increased width of the street would enhance the value of this remaining land to an amount greater than that of the additional land included in the street, it was evident that there would actually be a net saving by adopting the greater width.

The Council having adopted the scheme then promoted a bill in Parliament to secure the necessary powers for acquiring the several properties. It is stated that the proposal embraced the largest scheme of town improvement that had ever been placed before Parliament, and it involved the principle of "recoupment" to a larger extent than in any previous case. Over 40 powerful and influential companies and persons were petitioners against the bill, while several government departments had to be satisfied as to certain points. The Council was able to make satisfactory arrangements with most of the petitioners, but in other cases contests before parliamentary committees were necessary. The petitions involved the following principal questions, in addition to various details: (1) Whether the Council should be empowered to compulsorily acquire property not actually required for the new street, but required with a view to "recoupment," or whether its powers should be limited to the compulsory acquisition of the property actually required for the works; (2) whether, if the former were allowed, it would be right that in any cases there should be power to impose a special improvement charge; (3) whether or not the owners of properties required to be taken were in any cases entitled to insist upon reinstatement upon some other convenient site on lands to be acquired by the Council. The first and second of these questions had to be discussed before committees of Parliament and were decided generally in favor of the Council. As to the third, the Council endeavored to effect settlements by agreements, in order to avoid the cost of compensating the owners of trade and other interests on a basis of purchase under the Lands Clauses Acts, with all the attendant expenses of arbitration and litigation. Consequently arrangements were made for the reinstatement of premises in cases where large interests were involved. The bill was finally passed and became an Act, in 1899.

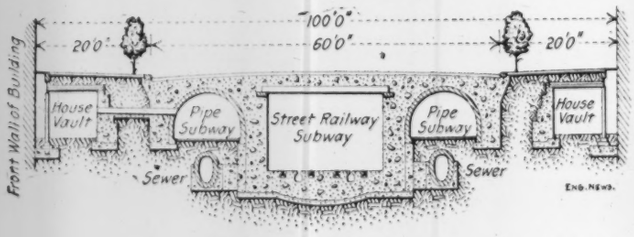

FIG. 1. CROSS-SECTION OF NEW STREET WITH SUBWAYS, AT LONDON, ENGLAND.

Maurice Fitzmaurice, Chief Engineer, London County Council.

In cases where improvements will involve the destruction of dwellings of the working or poorer classes, the Government very generally requires living accommodation to be provided for them elsewhere. By the clearance of the unsanitary Clare-Market area by this improvement, 3,172 persons were displaced, and about 3,700 more by the new street itself. Buildings for these have been erected, as well as a new lodging house which will accommodate 700 persons, on account of the destruction of an old lodging house.

The main street has been named Kingsway, and the crescent-shaped street at the south end has been named Aldwych, both of these names perpetuating ancient historical names. They were opened by the King in October, 1905, nearly a year within the time provided by the Act for their completion. The total estimated cost was as follows: Acquisition of property, $28,306,400; paving works, $795,500; provision for sites for rehousing, $1,500,000; total, $30,601,900. This for a single street 100 ft. wide and only a 0.75 mile long, will give some idea of the of land in London. The actual cost of the p erty was within the estimate, and with this the sums received for rent and sale of sur land, it appears that the improvement is not l

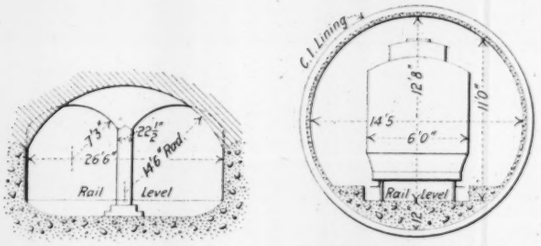

Fig. 3. Enlarged Cross Section of one of the Twin Tubes.

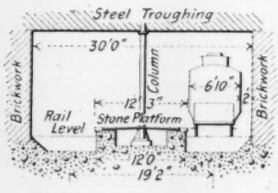

Fig. 2. Cross Section at Incline.

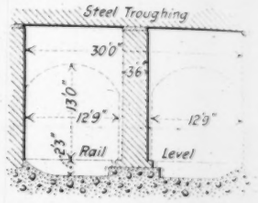

Fig. 4. Cross Section of Twin Brick Tunnel

Fig. 5. Cross Section at Stations.

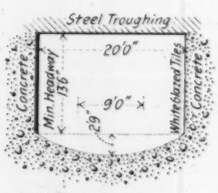

Fig. 6. Cross Section of Straight Portion of Shallow Tunnel under Kingsway.

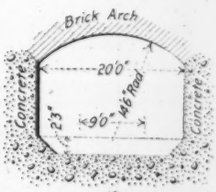

Fig. 7. Cross Section under Aldwych.

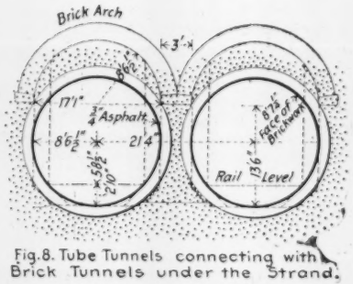

Fig. 8. Tube Tunnels connecting with Brick Tunnels under the Strand.

FIGS. 2 TO 8. CROSS-SECTIONS OF STREET RAILWAY SUBWAY AT LONDON, ENGLAND.

In connection with the improvement, the Council has been empowered to purchase the property fronting on the new street, and to dispose of it again, with the object of recouping itself for the cost of the improvement. The Council has not yet had occasion to exercise this power, but it is understood that it will be used only to involve any financial burden upon the ratepayers. This is an endorsement of the policy of acquiring sufficient property to enable the Council to benefit from the increased values due to the improvement, instead of leaving these to adjacent owners. The Council's policy in this respect was a new departure in municipal government. It is also to be noted that the city decided to abandon all saloon licenses of property involved, 51 in all, although it was estimated that if the vacant sites had been sold with the licenses included the additional value of the sites would have been some $898,000.

A general cross-section is shown in Fig. 1. The width of both Kingsway and Aldwych is 100 ft., with a 60-ft. roadway and two 20-ft. sidewalks. The former is nearly level for its whole length, the maximum gradient being a little less than 1%. In Aldwych, the gradients are 2% and 1.82% on the east and west branches, respectively. The streets are paved partly with wood blocks and partly with asphalt, and are lighted by high-pressure gas in lamps of 700 c. p. Arrangements have been made for planting trees along the sidewalks. In connection with the paving and other works, a semi-circular subway for pipes and wires has been constructed under each side of the roadway, and sewers have been built beneath the subways. These subways are 12 ft. wide and 7 ft. 6 ins. high.

The architectural side of the improvement was not neglected, and in 1900 the Council invited eight architects to submit suggestive designs for the elevations of the buildings to be erected in the new crescent road. The terms and conditions were drawn up by the Improvements Committee, after consultation with the Council's officials and with a deputation from the Royal Institute of British Architects. The designs were publicly exhibited, and the sum of $1,250 was paid to each of the architects. The designs will be used also in guiding the Council in its control of the architectural features of the entire street.

STREET RAILWAY SUBWAY.

It was originally proposed to obtain power to build a surface street railway, but it was decided not to include this at the time of applying for powers to establish the new street. At a later date, the shallow subway systems of Boston and New York were inspected, and it was concluded

t this new street would form an ideal opportunity for the introduction of this system into London. In 1902 the Council obtained from Parliament the necessary authority for a subway line starting at the Thames Embankment (the boulevard along the river) and passing under Wellington St., the Strand and Kingsway, rising to the surface at the north end of the latter to connect with the London County Council's system of electric street railways in the northern part of London. An extension along the Embankment and across Westminster Bridge to connect with the Council's street railways in the southern district is now projected. The underground conduit electric system is used throughout the subway line. The cost of the subway and street railway (about one mile in length) was estimated at $1,410,000.

The subway is built for double-truck cars 32 ft. long over the platforms, 6 ft. 10 ins. wide and 11 ft. high; with trucks 12 ft. 6 ins. c. to c., and stands 12 ins. above the rails. The track is laid with grooved girder rails on timber stringers and embedded in concrete. At the stations the tracks are spread for the island platforms by curves of 200 ft. and 300 ft. radius. The grades are from level to 0.5%, the steepest grade being used for the north incline approach and for the rise from the deep-level section under Holborn. The changes of grade are made by vertical curves of 500 ft. radius.

A general cross section of the street and subway is shown in Fig. 1, and a number of typical cross sections of the subway are shown in Figs. 2 to 8. Fig. 2 is the section at the foot of the open incline, and shows the double-track portal followed by two single-track brick tunnels. Fig. 3 is a section of one of the two deep-level tunnels under Holborn, with cast-iron lining. Beyond these the line is partly in tunnel and partly in "chambers" or covered cuts, as shown in Fig. 4, until it reaches the first station, the arrangement at which is shown in Fig. 5. The maximum headway of the stations is 13 ft. 6 ins., and in other parts of the line it ranges from 13 ft. to 14 ft. above the rails. The straight portion of the line under Kingsway is a shallow double-track tunnel 20 ft. wide, with roof of steel troughing. This is shown in Fig. 6 and continues to the second station, beyond which the 75-ft. curve of 90° at the south end of the street is made in two single-track rectangular tunnels 12 ft. 9 ins. wide. These unite in a single arched tunnel under Aldwych, as shown in Fig. 7. This is finally followed by two single-track brick arch tunnels terminating at the iron-lined twin tubes which carry the line under the Strand.

A POWERFUL MOTOR WAGON WITH FOUR DRIVING WHEELS.

In most motor vehicles only two wheels are driven from the engine, but we illustrate herewith a type of motor wagon for heavy service in which all the wheels are utilized in driving, steering and braking. In brief, the driving is accomplished by connecting the front and rear axles by a main shaft, which by means of bevel gears drives the shaft located within the hollow axles. Fig. 1 is a view of the wagon and Fig. 2 shows the arrangement of the machinery. The gasoline engine, A, is placed at the front end of the wagon bed, under the driver's seat, and drives the shaft B through the clutch C and the transmission or variable-speed gear encased in the box D. Ordinarily, the shaft B would be connected directly to the axle gears, but in this design it drives a main shaft E by means of a 5-in. Morse silent chain F. The shaft E extends between the two axles, and has a universal joint at G. It is enclosed in a tubular casing attached to the T-pieces of the hollow axles as shown at H. At each end of the shaft is a bevel pinion, J, gearing with a bevel spur wheel, K, on the inner axle, L. To allow of independent motion of the wheels of each axle, as in turning corners, there is the usual differential or compensating gear within each hollow axle; a third differential gear on the main shaft allows of independent motion of the two axles.

FIG. 1. MOTOR WAGON WITH BOTH AXLES DRIVEN.
Four-Wheel Drive Wagon Co., Milwaukee, Wis.; Builders.

The engine has four cylinders 6 × 6 ins., and is of the four-cycle type; it develops about 45 HP. when running at 750 revolutions, but can be run at much higher speed. The ignition is ordinarily by means of a battery, spark coil and timer, with an extra battery in reserve; but to insure against failures on the road, due to want of ignition, there is a separate system of wires connected to a high-tension magneto with an independent timer or distributer. The cooling water of the cylinder jackets is cooled by passing it through a large radiator at the front of the wagon, and a strong induced draft through this is caused by two 19-in. fans placed directly behind the radiator and driven at a speed of about 3,000 revolutions per min. This air is driven back over the engine. The clutch is of the multiple-disc type, with members of steel and cast iron alternating; there are ten of these discs, 10 ins. diameter, running in oil. It has no end thrust, and was specially designed to insure engaging gradually with the engine, thus avoiding danger of damage to shafts and gearing by a careless driver trying to apply the power too rapidly. The transmission is of the sliding-gear type, each gear being a steel forging with cut teeth. As generally applied, this gives forward speeds of 3, 5 and 8 miles an hour, and a single reverse speed of 2½ miles an hour. By changing the chain sprocket wheels on the main differential gear the wagon may be enabled to travel at 9, 10, 12 or 15 miles an hour on the high gear, but 9 miles an hour is considered the most suitable for so large a car.

The wheels are a special feature of the machine, being of wood, with a wooden face reinforced by iron inserts. One of the wheels is shown in Fig. 3. They are 36 ins. diameter and 8 ins. wide, and each has two ball bearings, 11 ins. diameter. The wooden tire is built up of wedge-shaped blocks, A, of rock elm, having the fiber lengthwise of the block. These are glued and nailed together, turned to the finished diameter, and with a shoulder on each side of the rim. Heavy steel rings, B, are shrunk upon these shoulders and secured by transverse through bolts. To reduce the wear of the face and to prevent slipping, steel wedges ¼ in. thick and about 3 ins. apart are driven into the tire to a depth of 2½ ins., as shown at C. As these are flush with the face it is claimed that they do not damage the paving. The tire or center is bored out to fit the hub, and is secured by bolts passing through the fixed flange of the hub on one side and a removable ring on the other side.

In steering, the front and rear wheels track, and each wheel is swung upon a vertical pivot. Instead of the usual outside knuckle to receive the pivot, the axles extend into the wheels and are connected to the bearing rings by vertical pins or trunnions, the rings being of sufficiently large diameter to allow of ample movement without fouling the axle. The lower socket of the trunnion is shown at D. The wheel is mounted upon the bearing ring and revolves upon it by means of its flexible connection with the driving shaft within the hollow axle. The main brakes are expanding bands, E, placed within a ring or flange, F, on the face of the wheel, and operated simultaneously by a lever at the driver's seat. The bands are 24 ins. diameter and 2 ins. wide, and the brake is strong enough to hold the car on a steep grade. There is also a brake on the shaft between the clutch and transmission gear. The clutch and shaft brake are both operated from one foot lever; the first motion of which releases the clutch, while by pushing it still further it applies the brake.

Some of these machines are already in service, being used by contractors and large wholesale houses. The one illustrated in Fig. 1 is 18 ft. long and 7 ft. wide, with a wheel gage of 6 ft., and the capacity is about 7 tons. The frame is of 6-in. channels, and all structural parts are of steel. Underneath the car is a 30-gallon storage tank, from which the gasoline is pumped to a 7-gallon tank feeding the carburetor by gravity. An overflow pipe connecting the tanks prevents overfilling the feed tank. At one side of the frame is a rope spool or drum, driven by the engine, and the shaft of this is shown at M in Fig. 1.

These machines are built by the Four-Wheel Drive Wagon Co., of Milwaukee, Wis., and we are indebted to that company for photographs, drawings and other information.

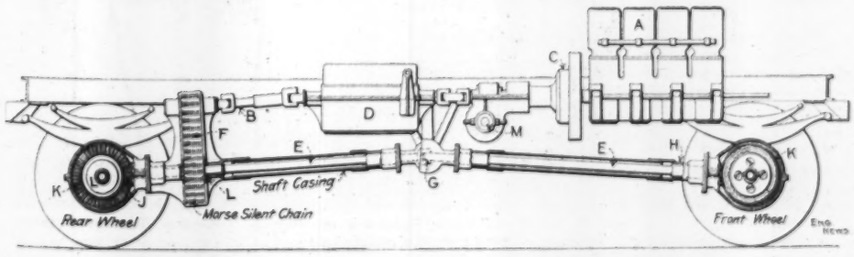

FIG. 2. ARRANGEMENT OF MACHINERY OF MOTOR WAGON.

THE TURBINE STEAMER "CREOLE" now being built by the Fore River Shipbuilding Co., of Quincy, Mass., for the Morgan Line (Southern Pacific Co.) between New York and New Orleans will be a twin-screw steamer with two 120-in. Curtis marine reversible turbines developing 4,000 brake-HP. each when running at 230 revolutions per minute. The vessel will be 440 ft. long over all, 416 ft. between perpendiculars, 53 ft. molded beam, and 37 ft. molded depth, with a normal draft of 25 ft. The loaded displacement will be 10,000 tons, and the carrying capacity 6,000 tons, while the speed is to be 16 knots. Steam will be supplied by 10 Babcock & Wilcox water-tube boilers with superheaters, carrying 250 lbs. pressure and with 100° of superheat; the boilers will have a total heating surface of 28,500 sq. ft., and a total grate area of 770 sq. ft. The electric plant will include two 75-KW. direct-connected turbine generator sets, and a 10-KW. engine-driven set, all for direct current of 110 volts.

SUBMARINE SIGNALING BY MEANS OF SOUND.*

By J. B. Millet.

The history of the submarine signal dates from 1895, when the United States was at war with Spain. Mr. A. J. Mundy, one of the chief inventors, while sailing from New Orleans up the Mississippi River, and sharing the general alarm created by the reported approach of Spanish torpedo boats, bethought himself of his youthful experience of hearing stones cracked together under water. With the principle of the telephone transmitter in his mind, he speculated whether the microphone could be utilized as a receiver of sounds under water. Not being himself an electrician, he wrote, on reaching St. Louis, to Professor Elisha Gray, of Chicago, one of the pioneers in telephonic invention, and enlisted his assistance in devising a practical apparatus. Their investigations were carried on during the summer in the open sea near Boston,† and the results obtained were such as to encourage the subscription of ample capital for continuing the work upon an extended scale. A scow large enough to be towed out to sea was built, and from it bells were suspended and rung for experimental purposes. A special shop was engaged and provided with a laboratory, and with all the machinery needed to make any apparatus that the inventors designed. The services of electricians, schooled in telephonic work, were engaged to devise a microphone adapted to use under water. This, in itself, was a most difficult undertaking, and was not successfully mastered for many years. As soon as the organization of the working force was complete the inventors sought the assistance of leading professors of acoustics, and experts in aerial signals for the sea. But to their dismay they discovered that students of sound had confined their researches to the air, and had little knowledge of the various principles of sound in water. Nor were any references to the subject to be found in text-books. The files of scientific publications were searched in vain for records of laboratory experiments with sounds submarine, so that the inventors were face to face with the necessity of depending upon their own unaided investigations. They reasoned quite naturally that whatever was true of sound in the air would be true of sound in water, but experience in time brought the conviction that it was most unsafe to trust to analogies between the two mediums. This made it imperative to construct and operate in the sea a large number of different forms of apparatus, in order to obtain results from which to lay down general lines of work. Every one working on actual experiments had to be trained by experience in the sea before observations could be trusted. All this occupied several years, and was attended with great self-sacrifice and devotion to the cause, not to mention personal risk. Death overtook Professor Gray in the midst of his work, and, not long after, continuous anxiety to succeed, combined with long hours of labor, undermined Mr. Mundy's strength, and he was obliged to abandon the work. At this juncture the direction of affairs fell to the writer.

The earliest attempts to invent apparatus which would enable ships to detect submarine signals contemplated the fastening of a microphone to the outer walls of the vessel, or the lowering of it overboard. The latter seemed the more practical, and much time was lost in trying various kinds of so-called "fish receivers"; for it was believed that if the microphone were fastened inside the ship the noises of the engines and other machinery on a steamer would fill the receivers with a roar and drown the notes of the bell. A few rather hasty experiments in this direction seemed to confirm this belief; but when the towing apparatus turned out to be entirely impractical (for among other defects it could not locate the direction of the sound waves), the inventors were driven to solving the problem from the inside of the ship.

Many years previous to this, Professor Lucien Blake, an American, who had been studying physics in Berlin, made the discovery in which lay the basis of practical submarine signaling. He found that bell sounds would pass readily from the water outside through the walls of floating structures. The old frigate "Constitution," with its 22 in. oaken walls, proved to be an excellent conductor of submarine sounds. In order to carry on extended observations arrangements were made for the use of four steamers of 3,000 tons each plying between Boston and New York, and permission was obtained from the United States Lighthouse Department to place submarine bells on three lightships on the route. From this time, operations were conducted along lines which led successfully to a practical system.

The sound-producing apparatus now used is as follows: (1) A bell (Fig. 1) weighing 160 lbs., operated by compressed air and perfected for use on lightships. This is suspended over the side of the vessel and lowered about 25 ft. below the surface. The blows are controlled by a code-ringing device in the engine room, under the supervision of the officers, so that each lightship rings its own number. (2) A bell of similar weight, supported on a tripod placed on the floor of the ocean and operated by electricity sent along a cable from a power-house on shore. (3) A buoy supporting a submarine bell, some 25 ft. below the surface. Situated above the bell is a disk working on the principle of a sea anchor; the difference in movement between this and the buoy operates a mechanism known as the "accumulator," by which the bell is struck with uniform force. On a calm sea the blows will, of necessity, be less frequent than when the waves are larger, but a wave of only 6 ins. in height will give sufficient energy to produce two blows per minute.

*Extracts from a paper read before the Society of Arts, May 2, 1900.

†Eng. News, Vol. I., 1901, p. 286; Vol. II., 1901, p. 297.

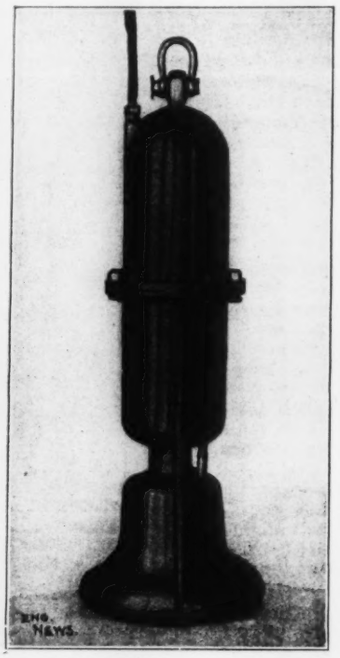

Fig. 1. Pneumatic Submarine Signalling Bell.

The tones of these bells have a range varying from six to twelve miles, according to the draft of the observing steamers. The pitch of the bells can be changed by altering the thickness of the rim, or by increasing the diameter. Those used in the earliest experiments weighed 1,000 lbs., and were cast for church steeples. Practice showed that the higher overtones of these bells were weak, while those very notes possessed the most penetrating qualities. In order to strengthen these tones, bells less than one-half the diameter, and weighing only 150 lbs., were cast, with a peculiarly thick lip, and these were found to produce a very high clear note. This diminution in the size and decrease in the weight of the bell greatly simplified the problem of designing a practical bell buoy. It was even found that a bell 4 ins. in diameter gave a high tenor note that penetrated the walls of a steamer at a distance of three miles. One of the puzzling results of experiments was, that instruments which gave a poor musical tone in the air often proved singularly efficient in water.

Nothing in connection with this invention is more remarkable than the musical quality of the bell-note when passing through water and transmitted by a selective microphone. However attenuated by distance—I might say, however unexpected by the listener—the bell-sound when first heard is unmistakable. Amid the surge and hiss of the rushing water its high, clear tone is almost startlingly isolated, and as the note becomes louder, with lessening distance, the sensation of a novice at the receiver is somewhat novel. And again, distance in no way makes the apparatus less trustworthy; were the listening ship suddenly to be lifted and dropped, heading in the same way, in the ocean five miles farther off, the bell-note, although fainter, would pass through the starboard and port transmitters with unaltered relative intensity.

The apparatus for receiving the sound consists of the following: (1) Two metal tanks (Fig. 2) about 22 ins. square, filled with sea water, fastened securely against the skin of the ship below the water line, and not less than a demonstrated distance from the forefoot; a specially designed microphone suspended, wholly immersed, in each tank; (3) wires connecting these microphones with an indicator box (Fig. 3) on the bridge. This box is of metal, circular in shape, and is fitted with two telephonic ear pieces, or receivers, enabling both observers to listen simultaneously. By moving a switch the listener can hear instantly the sounds of port or starboard at will. As a provision against accident, a duplicate set of microphones is placed in each tank, and by means of a simulating another switch on the indicator box the operator is able to connect either set at will.

The method of using the apparatus is remarkably simple. Let it be supposed that a ship equipped as above is coming within range of the sound of a submarine bell. The observer, with the receiver to his ear, listens to starboard and port alternately by quickly turning the requisite switch. Presently he hears the high, musical note of the bell, and, referring to the face of the indicator, can tell from which side the sound emanates. He then connects with the other side, and if the note of the bell can be distinguished there also, the observer knows that the ship is heading in the general direction of the signal. It then becomes his duty to compare, by turning the switch to and fro, the intensity of the bell notes on starboard and port sides. Experience has shown that by this method the bearing of the submarine bell can be rapidly determined to within less than a quarter of a point. Of course, if the bell is abeam, or nearly so, the sound will be heard only on that side. These observations can be made when the vessel is proceeding at its full speed, and, under such conditions, signals have been often accurately located at distances up to ten nautical miles. In foggy or thick weather, when speed is reduced, the diminution in the ship's noises enables the observer to hear the bell at greater distances. These results are valuable, not only on account of the long range of the signal, but because the direction can be accurately determined under all weather conditions, whereas it is notorious that sound-signals in the air are wholly untrustworthy. The writer does not suggest, however, that sound-signals in the air should be superseded.

Eighty-eight steamers and pilot boats on the Atlantic, including liners owned by the Cunard, White Star, Allan, Norddeutscher Lloyd, Hamburg-American, Campagnie Transatlantique, as well as several warships of the United States Navy, amounting in all to a gross tonnage of 400,000 tons, have already been equipped with this apparatus, which is manufactured by the Submarine Signal Co., Boston, Mass.

[The United States Government, some time ago, notified shipmasters navigating the coasts of Massachusetts, New York and New Jersey that, beginning June 1 and operating continuously day and night, excepting in case of accident, until noon Aug. 1, a submarine bell will be sounded from five lightships, viz., the Boston lightship and the lightships at Pollock Rip Shoals, Nantucket Shoals, Fire Island and Sandy Hook. Printed postal cards for making reports of observations are to be furnished masters of ships fitted with apparatus for hearing submarine signals, or others in charge of vessels not so fitted, by the Lighthouse Inspectors at Boston, Mass., or Tompkinsville, S. I., upon application. Such persons are asked to note carefully, while approaching any of these lightships, the distance and direction in which the signal is first heard, and how far it is carried after passing the lightship, as well as to note the direction and velocity of wind, the condition of the sea, etc.—Ed.]

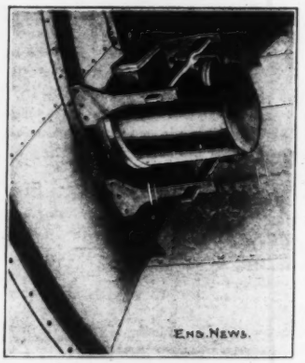

Fig. 2. Receiving Tank, Fastened to Interior of Ship's Hull, Containing Receiving Microphone.

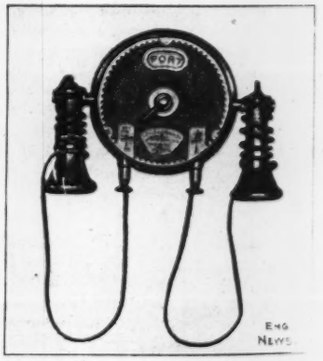

Fig. 3. Indicator Box for Determining Location of Bell.

THE PIESMIC BAROMETER.

The piesmic barometer's action depends upon the fact that any volume of air taken at a low pressure is more compressible than an equal amount at a higher pressure. Therefore when the atmospheric pressure is high, the air in the barometer tube is compressed less by the column of mercury than when the pressure is lower, and the barometer then reads high. The advantages claimed for this barometer (Fig. 1) over the mercurial and aneroid types are accurate readings under all conditions, small size, low cost and ease of transportation, there being

Fig. 1. Piesmic Barometer.

no vacuum to get out of order. The corrections for temperature are the same as for standard mercurial barometer.

The instrument is shown diagrammatically in Fig. 2. "A B C" is a bent glass tube, "A B" being made of strong capillary tubing of 1/10-in. bore, while "B C" is thin quill tubing. Tube "A B" is 7 ins. long, while the whole tube "A B C" has a capacity 35 times that of 1 in. of tube "A B." The end "A" of the tube is sealed into a small cast-iron cistern "E," which contains just enough mercury so that, when the instrument is in a vertical position, the weight of mercury above the opening in the tube will overcome the surface tension and allow the mercury to enter the tube. For the purpose of keeping out moist air and also to prevent the oxidation of the mercury, the cistern and interior of the tube have no connection with the external air; but the pressure of the contained air is kept at atmospheric pressure by means of tube "D," which connects a sort of bellows (F) with cistern E. This bellows is made of very thin paraffined paper so that, as the atmospheric pressure changes, it expands and contracts, thus causing the air pressure in the instrument to correspond to the external pressure.

The operation of the instrument is as follows: The tube "A B C" is turned into a horizontal

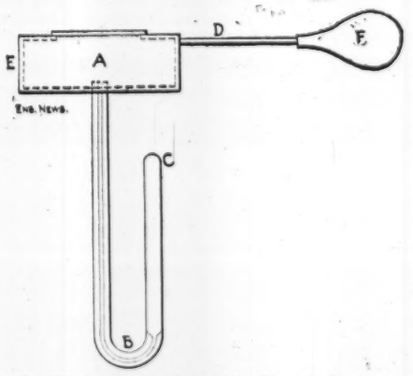

Fig. 2. Diagrammatic Sketch of Piesmic Barometer.

position, thus allowing the mercury to run back into cistern "E," and the air pressure in the tube "A B C" to become the same as the external air pressure. The tube is then righted to a vertical position, when the mercury settles into tube "A B" a depth corresponding to the atmospheric pressure. The scale of the instrument is laid off in inches, the division marked 30 being placed 5 ins. below the mouth of tube "A B," the division marked 29, 6 ins. below and so on. This scale is the result of having the total capacity to the tube equal to 35 times that of 1 in. of tube "A B."

The barometer is being placed on the market by F. Darton & Co., London.

THE ITHACA MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

The fourteenth annual meeting of this society was held last week at Ithaca, N. Y., at the same time as the summer meeting of the American Association for the Advancement of Science and the American Chemical Society. There was a good attendance and brisk and interesting discussion upon the papers and reports.

The report of the committee on statistics of engineering education, presented by Prof. William T. Magruder, of Ohio State University, showed that in 1904 there were granted a total of 2,493 degrees in engineering. The most important degrees bestowed were classified as follows:

	Degrees for Post-graduate work.	Baccalaureate degrees.
Civil Engineering	28	613
Mech. Engineering	20	615
Elec. Engineering	19	413
Mining Engineering	3	228
Mech. Eng. & Elec. Eng.	..	28
Metallurgy	..	14

The general testimony was that applications for men by employers were still much in excess of the number of graduates turned out.

The committee on the selection of a list of technical books for libraries presented through its chairman, Prof. C. F. Burgess, a provisional list of about 500 books, classified in some 25 disisions. Copies of the report, which is a pamphlet of about 50 pages may be obtained from the secretary, Prof. M. S. Ketchum, Boulder, Colo. The list, while on the whole well selected, was generally admitted in the discussion to be susceptible of considerable improvement.

Prof. Arthur E. Haynes, Professor of "Engineering Mathemathics" in the University of Minnesota, read a paper on the term "Engineering Mathematics," and a discussion arose to what extent the mathematical instruction of the engineer should be made different from that given to other students. It appeared to be generally conceded that mathematics should be taugh for the mental training they give as well as for their practical usefulness, and it was agreed that the practical application of mathematics might be overdone in the classroom.

Dr. C. M. Woodward, Dean of the School of Engineering and Architecture of Washington University, presented a progress report for the committee on Industrial Education, in which he remarked that there are two very different classes of people who are now taking an interest in industrial education. The first class is composed of employers of labor, who want more workers in the industries. The second class is made up of those who from philanthropic motives are interested in helping young Americans to make the most of themselves.

At the session of Monday afternoon, a paper on blank forms for the use of electrical engineering students was read by Prof. H. H. Norris, of Cornell University. It is generally conceded that certain blank forms for recording results of laboratory work, etc., are a great labor-saving tool for both teacher and pupil. An undue use of them, however, makes the student unable to rely on himself in experimental work, and his hours in the laboratory may become mere routine in which he makes and records certain observations without the least idea what it is all about. Prof. Norris suggested that since such forms are expensive to print, it might be practicable for a number of the schools to agree on certain standard forms, which could then be produced on a larger scale at much lower cost.

Prof. John P. Jackson, of Pennsylvania State College, read a paper on the function of the lecture in technical instruction. He condemned unreservedly the lecture which the students are required to copy verbatim as well as the one in which they are required to take copious notes. He would substitute the printed text book or mimeograph sheet for all such lectures. He preferred to make lectures infrequent and confine them to subjects in which it was particularly the desire to awaken the interest and zeal of the student rather than to give instruction. A very profitable discussion followed in which one of the best suggestions made was Prof. Jacoby's remark that he has succeeded in getting his students to do the lecturing and thereby awakened to a remarkable degree their interest in the work.

At the session Tuesday morning the nominating committee presented its report which was confirmed and the following officers were declared elected: President, D. C. Jackson, of the University of Wisconsin; Vice-Presidents, C. S. Howe, of the Case School of Applied Science and R. C. Carpenter, of Cornell; Secretary, W. T. Magruder, of Ohio State University; Treasurer, Anson Marston, of the University of Iowa; Council—Messrs. C. F. Burgess, A. M. Greene, Jr., J. F. Hayford, M. S. Ketchum, H. H. Norris, T. W. Palma and J. A. Thaler.

The President of the Association, Prof. Chas. L. Crandall, of Cornell University, then gave the annual address, the subject being the graduate school in engineering education. He concluded that there will be a larger and larger demand for post-graduate instruction and reviewed the work which Cornell University has done in this field.

The subject which aroused most interest at this session was a paper by Mr. John F. Hayford, of the United States Coast Survey, with the suggestive title: "Why not Teach about Men, the Most Difficult Tool an Engineer Uses?" The trend of the discussion was very similar to that taken at an earlier session in reference to a paper on "The Benefit of Philosophy to the Engineering Student," by Basset Jones, Jr., of New York, and to the set topic: "The Place of Cultural Studies in the Curriculum of Technical Colleges." It was generally agreed that some training in administration, in business and in the humanities may be of great benefit to engineering students; but the time is too limited to permit the accomplishment of very much and the boys themselves are as a rule too immature and not serious minded enough to get the best results from such instruction. The professor who attempts to instruct his students in elementary principles of engineering ethics will frequently be disappointed; yet it is probable that a large percentage of the students may derive much benefit from such instruction.

THE NEW ORE STEAMER "J. P. Morgan," built at Chicago for service in the great lakes, is 600 ft. long and 58 ft. beam, with a cargo capacity of 13,000 tons. It is entirely of steel, the only wood used being for the sheathing and flooring of the cabins; it has a double bottom 5 ft. deep, divided into 14 watertight compartments, and in this are ballast tanks with a total capacity of 9,000 tons. The screw is driven by a triple-expansion engine of 1,800 I. HP., steam being supplied by two Scotch boilers, 15½ × 11½ ft., working under induced draft.

A 40-TON STEEL FLAT CAR for carrying boilers, large castings, etc., has recently been built for the Cheshire Lines, of England, and is peculiar in that (like some other English cars for the same purpose) the floor is dropped between the trucks. There are four 9-in. I-beam sills, reinforced by top and bottom cover plates, and having a total length of 46 ft. 9 ins. The two sills on each side are connected at each end by a cross shaft through the webs, the middle of the shaft being carried in a link or hanger supported by another shaft in bearings on the truck frame. Cross pieces are riveted between the sills at intervals, and the outer sills have a number of rings for securing the chains or lashings. The height from the rail to the floor is only 20½ ins. The trucks have four wheels 4 ft. 6 ins. diameter, on a wheelbase of 6 ft. 3 ins., and have semi-elliptic springs over the boxes, but the springs are not equalized. Transverse frames or bulkheads prevent the load from falling the trucks. With a total capacity of 40 tons, the car will carry 25 tons on a length of 12 ft. at the middle. The car is 50 ft. long over the buffers, with trucks 44 ft. 9 ins. c. to c., and 32 ft. clear length of floor. The journals are 5½ × 8 ins. The car is equipped only with a hand brake, and that operates brakeshoes on only one pair of wheels.

A SYSTEM OF REINFORCED CONCRETE CONSTRUCTION WITHOUT WOODEN FORMS.

In most systems of reinforced concrete construction temporary wooden forms are necessary, and these represent a large proportion of the total cost of the work. This matter was discussed editorially in our issue of June 14, and in that article reference was made to methods of using forms which would be incorporated with the permanent structure. In the present article we describe the Wiederholdt system of construction in which no wooden or temporary forms are required. By the use of hollow tile blocks of special shape a thin shell of fire clay or cement tile is used as the mold and forms the finished exterior surface.

Fig. 1 shows the system as applied to wall construction, and plans have been prepared for this construction as specified by the Board of Education, of St. Louis, for use in fencing school grounds. This fence will be 5 ft. 6 ins. high, with panels about 8 ft. c. to c. of the posts. Fig. 2 shows sections of the tiles for the fence panels, posts, etc. It will be seen that the tile blocks are H-shaped in plan, the two long sides forming the inner and outer faces of the wall, while the web is reduced as much as possible, retaining only enough material and strength to hold the sides together while the concrete is being placed and tamped. By reducing its height, as shown, space is afforded for the horizontal reinforcing bars. By this arrangement there is a minimum of tile embedded in the concrete, and the wall is practically monolithic, with the concrete entirely surrounding all steel reinforcement. The vertical steel bars are embedded in the foundation in the usual way, and the tiles are laid between them, with the horizontal bars at suitable intervals, after which the concrete is placed, the tiling and concreting being carried up as the work progresses. The system is claimed to be specially adapted to wall construction, as it makes the cost of reinforced concrete comparable with brick and stone for such work, while giving a satisfactory exterior finish.

The system is adapted also to the construction of grain and other storage bins, and other classes of structures, and especially for smokestacks. In the latter case the tile forms an exterior finish and interior protection for the concrete, and it can be used in making tapered stacks, while with wooden forms the cost of tapering would be very high, owing to the special construction of the forms. Fig. 3 shows the tiles for the smokestack for the warehouse building of Martin

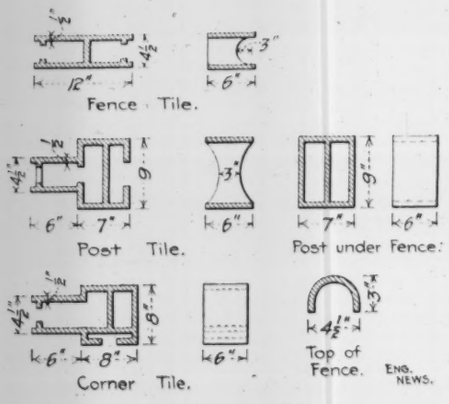

Fig. 2. Forms of Tile Blocks for Reinforced Concrete Walls on the Weiderholdt System.

Shaughnessy, 22d Ave. and Washington Ave., St Louis, for which Barnett, Haynes & Barnett are the architects. The smokestack will be 91 ft. high; for a height of 50 ft. it will be 3 ft. diameter inside, with walls 8 ins. thick; in the upper part the thickness will be reduced to 6 ins., giving an inside diameter of 3 ft. 4 ins. The vertical steel bars are to be ¾-in. square, 12 ins. c. to c.; the horizontal bars will be ½-in. square, spaced 12 ins. apart in the thicker section and 24 ins. apart in the thinner upper section. The concrete is specified to be composed of 1 part of Portland cement to 3 parts of clean sharp river sand, mixed dry, and then having enough water added to bring it to the consistency of damp clay; the concrete to be tamped until water appears on the surface.

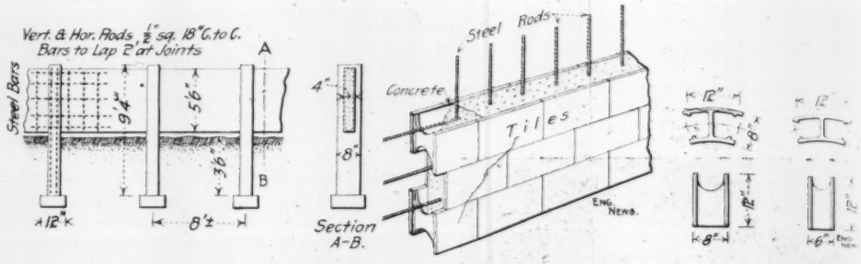

FIG. 1. REINFORCED CONCRETE CONSTRUCTION WITHOUT WOODEN FORMS; WIEDERHOLDT SYSTEM.

Atlas Construction Co., St. Louis, Mo.

This system of construction is being introduced by the Atlas Construction Co., Missouri Trust Building, St. Louis, Mo.

COST AND METHODS OF REPAIRING ASPHALT PAVEMENTS IN VARIOUS CITIES.*

Your special committee appointed for the purpose of ascertaining the costs and methods of repairing asphalt pavements herewith submits the following report:

The accompanying blank [not reproduced] was sent to 20 of the leading cities in the country which have the largest amount of asphalt pavements, with the request that it be filled out in detail. The object was not only to ascertain the actual cost and method of repairing asphalt pavements, but if possible to determine the cost of repairs according to the age of the pavements. Only eight of the cities replying have kept their records in such shape that this could be obtained and the results are embodied in the accompanying table. The figures are all for the year 1905 except Washington, which is for the year ending June 30, 1905. Although not being able to furnish just what was desired, the following cities gave information regarding their methods:

PHILADELPHIA.—There are about 25 miles of asphalt out of guarantee, and it is stated they all require resurfacing entire. The prices for resurfacing in patches of 100 sq. yds. or less for 1906 are $1.19 per sq. yd.; patches between 100 and 500 sq. yds., $1.17 per sq. yd.; for surfaces from 500 to 1,000 sq. yds., $1.11 per sq. yd.; over 1,000 sq. yds., $1.07 per sq. yd. It is said the amount expended per year depended upon the annual appropriation rather than the need of the streets.

MINNEAPOLIS.—The area repaired last year was wholly in streets under guarantee where the contractor had failed to live up to his agreement. They were made at a cost of $1.65 per sq. yd. The total yardage laid under this arrangement was 4,525 sq. yds., but no statement was made as to the total area of the streets as repaired.

MILWAUKEE.—No account is kept of the cost of repairs by years, so nothing definite could be obtained.

OMAHA.—The repairs are made by a municipal asphalt plant, and while no statement was made of the cost by the age of the pavements, the total of 5.8% of the entire yardage repaired was relaid. This would mean at a cost of 82 cts. per sq. yd., an average of 4¼ cts. over the entire area.

KANSAS CITY.—The method of repairs is such the following quotation is made from a letter of the gineer:

We have repaired since 1903, when the first repa of asphalt pavements out of maintenance was begu

NEW YORK CITY, BOROUGH OF MANHATTAN.—It is reported in 1904, 265,000 sq. yds. were maintained at a cost of $201,167, or practically an average of 76 cts. [per sq. yd.] per year; in 1905, 460,882 sq. yds. at a cost of $161,800, or an average of 34 cts. per sq. yd.; in 1906 there will be maintained 760,091 sq. yds. at an estimated cost of $216,233, or 28½ cts. per sq. yd. These figures of Manhattan seem excessive and are very much more than is paid by any other city. This is probably due to the heavy traffic of the Manhattan streets and the fact that many streets have been paved with asphalt where that material does not make an economic pavement.

The committee feels that some benefit has been derived from these investigations, but also feels that these reports show how little uniformity there is in the practice of the different cities, and that some officials do not care enough about obtaining the information to keep the proper records. It would seem a comparatively simple matter to so keep the records of asphalt repairs that a permanent good would be obtained and by comparing the methods and costs of other cities a general benefit not only to themselves, but to their officials, would be derived. Quite a number of the cities to whom circulars were sent did not even reply, although it was stated in the letter accompanying the blank that copy of the report would be sent to all officials replying. The committee would recommend that when the report is printed it be sent to the city engineer or official in charge of the asphalt repairs in all the cities of the country containing any material amount of asphalt pavement, with the request that permanent records be so kept that a table similar to the one accompanying this report can be made out and in that way the costs of repairs to asphalt of the different cities can be intelligently compared.

*Report by Geo. W. Tillson, Clarence D. Pollock and O. W. von der Bosch, a Committee of the Municipal Engineers (Society) of the City of New York. The report is dated March 22, 1906.

Age of pavement, yrs.	Brooklyn: Sq. yds.	Brooklyn: Cost per sq. yd.	Buffalo: Sq. yds.	Buffalo: Cost per sq. yd.	Rochester: Sq. yds.	Rochester: Cost per sq. yd.	St. Paul: Sq. yds.	St. Paul: Cost per sq. yd.	Toronto: Sq. yds.	Toronto: Cost per sq. yd.	Washington: Sq. yds.	Washington: Cost per sq. yd.
6	122,491	.001	.....	.....	.....	.....	5,077	.0016	.....	....	63,520	....
7	82,937	.007	7,862	.0110	.....	.....	.....	.....	.....	....	70,184	.003
8	421,274	.030	139,226	.0210	.....	.....	.....	.....	.....	....	40,150	.002
9	189,415	.018	86,458	.0129	27,680	.0253	11,385	.0812	.....	....	70,493	.002
10	209,937	.043	241,666	.0028	17,844	.0283	77,115	.0945	10,499	.043	42,397	....
11	44,056	.027	494,765	.0147	11,003	.0150	.....	.....	43,871	.110	83,892	.003
12	41,187	.028	438,540	.0276	57,155	.0693	.....	.....	5,456	.043	77,462	.010
13	36,706	.040	325,098	.0419	57,558	.0832	.....	.....	41,773	.100	81,078	.014
14	27,419	.060	305,449	.0618	23,548	.0550	.....	.....	20,027	.069	96,863	.008
15	5,278	.026	290,862	.0458	72,573	.0530	.....	.....	47,276	.044	128,988	.010
16	20,069	.064	216,660	.0590	54,397	.0788	2,096	.0090	32,640	.032	204,585	.023
17	87,442	.102	108,215	.0430	5,134	.0545	9,654	.0990	.....	....	89,336	.032
18	20,504	.151	75,379	.0044	36,352	.0400	48,621	.0076	.....	....	20,754	.010
19	235	.031	37,117	.1219	17,433	.0571	30,351	.0015	.....	....	37,311	.011
20	3,448	.074	39,398	.0376	9,482	.0864	.....	.....	.....	....	9,190	.004
Prices.	Wearing surface = 67 cts. per cu. ft. Binder = 25 cts. per cu. ft.		1st 6 months = $1.23 per sq. yd. 2d 6 months = 74 cts. per sq. yd.		$1.28 per sq. yd.		$1.65 per sq. yd.		89 cts. per sq. yd.		Wearing surface = 49 cts. per cu. ft. Binder = 25 cts. per cu. ft.	

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Entered at the New York Post-Office as Second-Class Matter.

We discussed last week the use of coal tar to improve macadam roads. In this issue we print a paper by a well-known engineer describing experiments in making paints from coal tar for the protection of metal surfaces. It is stated that such paints were made at a cost of only 10 to 15 cts. per gallon and gave satisfactory results. It is of course well understood that where paint must be applied with a brush to surfaces more or less intricate, such as the surface of an iron bridge, for example, the great bulk of the cost of painting is for the labor of application. Any saving in the cost of the paint which is made at the expense of its durability, therefore, is saving at the spigot and wasting at the bunghole. On the other hand, where large flat areas are to be covered, like a steel roof or an expanse of corrugated iron siding, so that the paint can be applied with broad brushes, or where articles can be dipped, the labor can be reduced to small proportions, particularly if a paint is available so cheap that if can be put on without thought of economizing material.

At present coal tar in enormous quantities is being burned to get rid of it by the producers of gas in this country, and it is practically a waste product. If this material can be made use of to protect the iron which one sees on every hand exposed to the weather and rapidly being transformed back to its original state of iron oxide, the knowledge how to do it is well worth the attention of engineers.

The proper method of supplying feed-water to locomotive boilers was discussed at a recent meeting of the Western Railway Club, and it was stated that trouble is still experienced from the cold water settling to the bottom of the boiler when the injector is working and the engine is not using steam.

It is, of course, often desirable to turn on the injectors full force when the engine is standing still or running with steam shut off, to prevent waste of steam at the safety valve; but the trobule is that when the throttle valve is shut, circulation in the boiler stops, and cold water fed into the boiler then is apt to settle to the bottom and not mix with the body of the water already in the boiler. This causes unequal expansion and severe internal stresses, and is claimed to be a common cause of leaky tubes.

Similar troubles with marine boilers have been serious enough to compel the use of auxiliary pumps or injectors to compel the entering feed to mix with the rest of the water. In locomotive practice, one plan for remedying the trouble referred to is to locate the check valve near the upper part of the boiler and just in advance of the firebox, delivering the feed into pipes which extend longitudinally through the steam space; these pipes have perforations in the top through which the feed water overflows and falls into the hot water, being distributed in fine streams over a considerable area of the water surface. Another plan is to place a pocket inside the boiler, opposite the mouth of the feed pipe (which is in the usual position), so that the cold feed water cannot sink directly to the bottom, but must flow up and over the edge of this pocket, falling upon the top of the hot water. A simple and effective plan which has been adopted as standard practice by the Chicago, Burlington & Quincy Ry. is to fit an elbow or nozzle to the inlet from the check valve so that the feed water is thrown upward in a strong stream into the body of hot water already in the boiler.

In England the Lancashire & Yorkshire Ry. has for some time been experimenting with the Halpin thermal-storage system for the supply of hot feed water to its locomotives. On the top of the boiler is a horizontal tank about 3 ft. in diameter and 12 ft. long, having a capacity of about 500 U. S. gallons. This encloses the dome and is connected to the boiler by a header. The feed water is delivered by the injector to this tank and is heated by steam when the engine is standing still or drifting down grades, so as to prevent the waste of steam through the safety valves. The hot water is then fed to the boiler as required. At a recent meeting of the British Institution of Mechanical Engineers it was stated that this railway has six large tank engines of the 2-4-2 class equipped with the thermal-storage system, and that their average increase in efficiency over similar engines not so equipped is about 4 per cent., although on individual runs it is as high as 12 per cent.

It may be interesting to note here that in the Flaman locomotive boiler, at one time used on some French railways, the feed was introduced into an upper drum, or tank, but in this case the drum was in continuous communication with the main barrel, and was, in fact, a part of the boiler. The barrel of the boiler was entirely filled with the tubes and the normal water level was in the upper drum. With this arrangement the feed water, being delivered at the top, was compelled to mix with the hot water in the boiler and could not settle directly to the bottom of the lower shell.

TECHNICAL STANDARDIZATION.

A vast amount of the technical work and the industrial production of the present age bases on certain agreements for uniformity, either drawn up by the producers or accepted by them, which are currently known as standard lists, standard designs, standard specifications, etc., or, in short, as standards. Many such standards are now established in this country. There is also much activity at present in forming new standards and revising old ones.

Thus, the American Society of Mechanical Engineers is at present considering the adoption of new standards for sizes, threads and heads of small machine-screws. Again, the American Society for Testing Materials during the year past has formally adopted several new specifications for important engineering materials or products, as its standards; and while it accomplished no further work at its most recent meeting (three weeks ago), the coming year may be expected to show a revival of its activity.

To quote another instance: Not long ago the National Board of Fire Underwriters, through a special committee, made an extended study of enclosed fuses for electric circuits, and, as a result of this study, prescribed certain forms and sizes of body and terminals, and certain requirements which such fuses must meet to secure the board's approval. This action has already brought about increased uniformity in the productions of fuse-makers, and bids fair to establish the board's specifications as standards for the manufacture of enclosed fuses. Whether or not they may secure universal adoption, they will at any rate be influential factors in molding the commercial development of fuses, and will dominate a not inconsiderable part of the market.

An earlier stage of the genesis of a standard is found in the electric railway field. The location of the third-rail contact surface with respect to the gage corner of the track-rail is now a detail of great interest to constructors of electric railways and engineers entrusted with electric terminal and suburban equipment of main railways. Efforts have already been made, by persons and corporations who have much concern in securing uniform location of third-rail, to bring about a conference of engineers and others of commanding position in third-rail work, for the purpose of coming to a practical agreement on a preferred location. These efforts do not promise immediate success, but they show that foresight to future necessities has already begun to make sentiment for a standard prescription in the subject. It is certain that in a relatively short period there will be a standard usage in locating the third-rail, whether this shall be brought about by conference action or by automatic selection; the exigencies of railway interchange can not permit a diversified practice to become established.

These examples, which might readily be multiplied very largely, indicate the present activity in the field of technical standardization.

In the sense that unhindered evolution is a process of natural selection, technical standardization is a process of artificial selection in the mechanical world by which the disappearance of the weaker or poorer types is hastened and the survival and supremacy of the fittest type is made certain. If in this hastened evolutionary process a mistake be made in choosing the best type, the standard thus artifically created will be likely to develop early ailments and possibly perish; or, if it persists, it will exert a harmful influence on the progress of all related industries. This fact merits careful note by all technical men who are either active in standardization work, or likely to be affected by it. It is of special importance in the case of such standards as cannot be modified after the standard has once been promulgated and accepted, or can be varied only with great difficulty.

The objects of standardization and the value of a standard are subject to wide variation. In one case standardization may be indispensable to industrial intercourse or interchange in a given class of production or commerce, and correspondingly the standard will have high value and will attain a remarkable sanctity and fixity. The gage of railway track (which, however, was "standardized" by a process of natural selection) furnishes an excellent instance of this, and the car coupler is almost as good an example; in either case interchange depends vitally upon conformity to a common type. In another case a standard may be highly important, but not essential; the selection of T-rail sections and of standard car-wheel dimensions will serve to illustrate this. In still other cases a standard will be a commercial convenience, but will have little or no relation to interchange; in most such cases the definition of suitable quality has a large place among the objects of standardization, as in the instance of standard axles and journals for freight cars, but in some cases even this factor is not present, as in the matter of wire gages and sheet-metal gages, which are purely commercial conveniences.

Speaking generally, a standard is of higher value in proportion as it is more absolute or mandatory, since it places a more urgent demand upon the user. But this is true only in a general sense. It is more accurate, perhaps, to appraise the value of a standard in proportion to the universality of its use, irrespective of whether the purpose of the standard demands universal conformity. Thus, the standard list of I-beams and channels adopted by the Association of American Steel Manufacturers years ago, is in universal use in this country, although it does not in any way

base upon universal conformity or require interchangeability of the productions of different makers, and this standard has proved to be of very great value to the steel producing and steel using circles of the country.

If the only purpose of creating a standard be to secure uniformity, whether for reasons of interchange or for mere commercial convenience, almost any selection may give satisfaction, provided the standard is adopted by all makers and users of the article concerned. That is to say, in such a case nothing more is often required than a conference of makers under a sort of caucus agreement, to select the standard forms and dimensions by majority vote; of course, such a conference can rarely be brought about except through the action of some independent society or organization of standing. On the other hand, a standardization involving quality must be handled in radically different manner; the subject must be fully studied and a decision as to "best" be reached by scientific methods. Where uniformity is involved together with quality, a speedy decision may be more valuable than a better one more slowly worked out. If quality alone is the object, then the most deliberate procedure is in order.

In the United States no central action in the formulation of standards has ever been taken, except perhaps the recent work of the American Society for Testing Materials. Certainly there has been nothing similar to the remarkable movement now under way in England, represented by the British Standards Committee. That body, convened by and upon the initiative of a technical society, with the support of other technical and commercial bodies, is engaged in a wholesale standardization of industrial and technical productions, with the purpose of improving the hitherto standard-less condition of the United Kingdom. We in this country, fortunately, have never required so drastic and forced a proceeding as this.

One of the earliest mechanical standards established, perhaps, was the Sellers screw-thread and list of machine screws, championed by the Franklin Institute, adopted later by a department of the U. S. Government, and soon adopted quite generally throughout the mechanical industries of the country. It is one of the most valuable of our standards. The vast extent and range of use of screws and bolts made universal interchangeability a pressing necessity. A standard list of diameters and pitches of screws was the first need, but as this matter was interdependent with form of thread, and as the latter was in itself subject to standardization for accurate interchangeability, the adoption of standards waited upon the selection of the best form of thread. The advantages which came to American manufacture from this piece of standardization are difficult to over-estimate.

The screw-thread standard pictures clearly some of the difficulties and uncontemplated results of standardization. When the Sellers thread was adopted as a standard it was looked to as a universal screw-thread. But it has not proved to be such: the sharp V-thread has never been wholly displaced, and to-day exists side by side with the Sellers as a standard. The fact had not been anticipated that, for work requiring tightness against leakage along the thread, the V-form would prove the better in practice, a fact founded on the very imperfections which in other service constituted a serious defect of the V-thread. It appears, thus, that an attempt at standardization, even when conducted with the very best of ability and thoroughness, may not attain all the desired ends. Again, in this same field of screw-thread standardization, an example of direct failure may be observed. In England, about the time the Sellers thread was put into use here, the Whitworth thread was suggested as a standard, and powerful support was given to the suggestion; we believe the thread was even given governmental sanction. Yet the Whitworth thread has absolutely failed to establish itself as a standard, and, as a result, the field of screw-threads in England is to-day as far from standardization as it was forty years ago. It would seem that the artificial selection represented in standardization work cannot always be an effective substitute for the natural selection of time and development.

A standardization of very different kind, and one embracing a large number of individual items, is that done by the Master Car Builders' Association. For many years past this organization has been the official representative of the railways of the country in matters concerning railway car construction. The interchange of cars between different railways, a fundamental feature of our modern system of transportation, is feasible only when the rolling stock of one road will couple with that of another road and will fit its track. Under present railway practice, also, it is desirable that many of the detail parts of cars should be uniform on all roads, so that a "foreign" car received in defective condition may be repaired without delay. The Master Car Builders' Association has provided for these requirements by prescribing standards of form or construction, or both, for a great number of the essential parts of a car. Contours of couplers and knuckles, sizes of axles and bearings, draft rigging, springs, center plates, car doors, brake rigging, air-brake hose, etc., have been so standardized. A special feature of most of these standard provisions is that they have been frequently, some of them continuously, modified as the need for improvement became evident—a feature impossible with most technical standards, and difficult in all cases except where a regularly working organization with almost autocratic power has the work in charge, as is the case here.

A peculiar kind of standardization work, of great importance, has been done by the fire insurance interests of the country, as represented by the National Board of Fire Underwriters; by the executive organization of the New England "factory mutual" companies; by the National Electric Code Committee (of the national board) and other related organizations. The Underwriters' Fire Pump is an early result of the efforts of these interests. The National Electric Code, in formulating which the insurance people called in representatives of many phases of electrical work, who indeed are still associated with them in constantly revising the provisions of this code, is another notable product. Fire nozzles, fire hose, automatic sprinklers, slow-burning timber factory construction—the famous "mill construction"—the widely known metal-covered wooden fire doors and shutters and many other details of fire protection work have been studied, improved, codified, and standards for their construction promulgated by these organizations.

It is to be noted that none of this work is dependent upon general conformity, in the sense of making interchange possible, but is at the other end of the range of standardization purposes: setting a mark of good practice in quality and construction. In such standardization for quality only, it may easily happen that only those desiderata of quality and construction are considered which concern the special interests who draw up the standard. Thus, it would not be strange if the fire insurance bodies had formulated specifications and standards satisfying the interests of fire protection only. But, fortunately, they have ever taken a broader and wiser view of the matter: namely, that their proposed standard would be most effective and most certain of general acceptance if it were not merely good from the insurance standpoint, but also the best from the manufacturer's and the user's standpoint. As a result, the fire insurance prescriptions for construction or quality have a large value over and above their relation to fire protection.

Much standardization work has been done by the independent initiative of various technical and commercial societies. This has, in the main, had the object of setting standards of quality, with little relation to interchange, but several exceptions to this are on record. One such is the adoption by the American Society of Mechanical Engineers, a few years ago, of standards for dimensions of generator base-plates in direct-connected steam-electric sets. The recommendation of model T-rail sections by a committee of the American Society of Civil Engineers, a number of years ago, had something of this same aspect. An important recent piece of work of the same kind is the formulation by the New England Water Works Association of standards for hose couplings (including nozzle and hydrant connections). This, it may be pointed out, is a very perfect example of that class of standardization which has the duty merely of bringing about an absolute uniformity, and has nothing to do with quality. The various sizes and styles of hose couplings hitherto made satisfied each of them all the requirements of isolated service; but the great desideratum remained that hose and hydrants from any maker, used in any city, should accurately couple up with hose of any other maker or from another city. This desideratum could not be fulfilled before the recent standardization because the preferences of different manufacturers, the varying specifications springing from the whim of the authorities in this or that city, and the like, could not be harmonized until some authoritative third party, independent of both makers and buyers, studied the needs of the case and drew up a standard which all might accept without loss of commercial advantage or personal dignity.

A powerful and active agency for standardization of a specific kind is the American Society for Testing Materials. The exclusive field of this society is the standardization of quality of the engineer's and manufacturer's raw materials: iron, steel, cement, and the like; and constructive elements, such as rails, structural shapes, boiler plate, paving brick, etc. Such materials, produced and consumed in enormous quantities, are everywhere in substantially the same service, and may suitably be of one uniform quality. If the manufacturer need make only one grade of a particular material (steel for structural shapes, for example) he will economize in production cost, will more rapidly perfect quality and uniformity, and can meet the variations of demand more quickly; and, on the other hand, the user has before him a definite normal material, of quality substantially as high as could be obtained, equal to that used in similar construction elsewhere, and certain to give service equal to that elsewhere evidenced. In the case of a secondary material, like malleable iron, the establishment of a standard renders available a specific material: instead of knowing that by certain treatment of certain castings, they may be partially toughened, in variable degree depending upon the iron, the article and the treatment, the engineer or manufacturer is informed that a material of specified qualities is available for his use, if he calls for malleable castings to the standard specification.

Still other service is rendered by a carefully prepared and generally accepted standard in the case of such material as Portland cement. This latter substance has been (and is being) quite empirically developed, its scientific phases are but partially explored, and its behavior in the hands of the engineer is often perplexing or troublesome. The variation in service characteristics which could be found among the many brands on the market has hitherto been great. One cement was "strong," another was "always reliable," another was "highly uniform," another had "high sand-carrying capacity," and so on; and all these advertising claims reflected (if they did not correspond to) equally large variation in actual behavior. The whole matter, in the absence of definite theoretical guidance, rested on empirical deductions. The accuracy of the latter, again, was seriously vitiated and made confusing by variations in the handling of the material: amount of water added, character and proportion and degree of mixing of sand and stone, placing and tamping, surface treatment, etc.

Under such conditions, it is readily seen, the clarifying of professional experience is a very slow process, necessarily entraining many errors. Much more could be accomplished, both to clear up knowledge and to prevent errors, by a representative, serious, energetic conclave of makers and users, to arrive at an average conclusion

as to the grade of material most suitable for use, while yet cheaply and readily manufactured. The American Society for Testing Materials acted in this idea, by assembling a large representative committee, for the formulation of a standard specification under which all makers could furnish and all users could buy cement. The resulting specification, adopted two years ago, is an expression of substantially the best empirical conclusions which can yet be drawn, on the bases jointly of the needs of service and the resources of production.

While the cement specification is most typically such a summary of empirical knowledge, a strong tinge of the same characteristic appears in other specifications for materials, notably in the specifications for rolled steel and for railway car axles. The preparation of standard specifications for materials, as carried on by the American Society for Testing Materials, derives a great part of its value from these empirical summaries, which are to-day—and probably will be for a long time to come—vital elements in the selection of nearly all constructive materials. A device, or a technical object, can be *designed*, on the basis of fairly well known natural laws, to meet specific conditions of service, and the designer can accomplish any stipulated result usually within a very wide range. A material, on the contrary, cannot be designed; its suitability for given service can be judged only by making it in many variations and trying it for long periods in many kinds of service, a task which is only rarely within the view of one man. A standard specification gives him a summary of the results of such selective process.

LETTERS TO THE EDITOR.

The Alaska-Siberia Ry. Again.

Sir: You say in your issue of June 21, "Why should railways be built thousands of miles to haul traffic which can be carried to market far more cheaply by sea?"

Are not all the coasts paralleled by railways, with branches leading into the country to supply towns, mines, and move products? Merchandise does not originate in a few limited places and always move long distances: The way traffic counts for the most, besides the ports in that latitude are closed by ice from six to seven months a year.

In 1843 Daniel Webster said: "Oregon is only fit for wild beasts and savages which are worse," and was in favor of letting the British have the territory if they wanted it. In the '70's the Northern Pacific Railway was sold to ex-Governor Blair of Michigan for $350,000, and most people thought it dear at that in such a country. President Blair of the Northwestern Ry. system once said he would rather have one hundred and sixty good ties than one hundred and sixty acres of land in Nebraska. Fifty years ago western Canada would not have sold at auction for five cents an acre. Eastern Siberia and Alaska are cold countries, yet worth a system of railroads. Let the Arctic currents and the waters of the Yukon River be shut off by a breakwater, which will make a vast difference in coast climate and the Aleutian Islands—an isthmus to cut through at the south and a breakwater at the north.

Yours truly,

R. J. Mershon.

1817 West 105th St., Chicago, Ill., June 25, 1906.

Swing Bridge Centers and Movable Bridges in General.

Sir: Referring to Mr. Chas. C. Wentworth's letter in Engineering News of May 31, 1906, on the "Design of Rim Bearing Turntables," the writer would say that he believes that the treatment of the case proposed in that letter would overcome the weak points of the ordinary design of such bridges, but that the remedy is impracticable on account of the great expense involved. Another difficulty would be in the material increase in distance from base of rail to top of masonry which already is larger than convenient in most cases met with in practice.

It seems to the writer that the trunnion bascule bridge type has the great advantage over all other styles of movable, turning or rolling bridges of bringing the load on two fixed points of bearing on the masonry. The center-bearing draw, while theoretically giving a definite distribution of load, has the practical disadvantage of tipping, as pointed out by Mr. Wentworth. The trunnion bascule type is not new, but of late years it has shared in the general advance of bridge work in improvements both in design and shop practice and according to the writer's experience can in most instances be built at about the cost of an ordinary swing span. It seems, therefore, that it is worth while to look into the merits of a trunnion bascule design before determining on the type of a movable bridge required.

Yours truly, Henry Szlapka.

342 Mint Arcade, Philadelphia, Pa., June 18, 1906.

More Concerning the Right of an Engineer to Have the Best Offer for His Services.

Sir: The facts stated by "R" in your issue of June 21, 1906, interest all civil engineers who are so unfortunate as to have fitted themselves specially for railroad work. The writer knew of a case of an offer being withdrawn by another railroad at the request of the chief engineer employing the man. The headquarters of the railroad were in Cincinnati. The young man had charge of some work at the munificent salary of $65 per month. He was offered $100 per month by another company.

By personal experience in Chicago the writer has known that between some chief engineers of railroads having headquarters there, it is customary to ask permission before making an offer to an employee of another line. Just how far this custom extends it is impossible to state. Its influence on salaries would not cause a boom at any rate.

Employment by railroads is a one-sided question altogether. Nothing is considered except the interests of the corporation. The engineer works by the month nominally. So far in his experience the writer has not run across a railroad that made a practice of giving engineers a month's notice of the termination of their employment. They are entitled to that, I believe, by law in most employments, when the question of competency is not involved.

In employing engineers statements are usually made about the duration of the work. To induce a man to work for lower salary he will frequently be told that it will last for two years, for instance. But just the same they may shut the work down and fire everybody with a possible two or three days' notice. The railroad does not feel under any obligation to the men although they probably would not have taken the place at all, or at least would not have taken the salary, if this had been understood. Is this fair?

One of the largest railroads in the country makes a practice of holding out steady employment as a bait to new men. Yet the writer has known that company to discharge a whole body of men without any notice whatever. Another scheme which the same railroad works is to employ a man at one grade and when he is in the service to assign him to duties of a higher grade. A transitman will be assigned duties as an assistant engineer; rodmen will be given a transit and so on. Salaries of course remain at the lower grade. Promotion comes to him who waits and diligently works a "pull."

If there are any ethics which apply to railroad employment, the writer has not discovered, in nine years of practice, just what they are. A young man thinking of going into railroad service should understand that he is "taking a chance." The game strongly resembles poker. In the first place never play with strangers, or, in other words, have a pull handy. If with strangers remember that they shuffle the cards and there is no telling how many packs they have up their sleeves. Also remember that the percentage is in favor of the house in the long run even in a fair game—and stay out. The railroad holds a big stick and knows you can't "squeal," for you have to stay on apparent good terms with the company in order to use it as a reference for a new position.

Yours truly,

A Railroad Civil Engineer.

Chicago, June 26, 1906.

THE TUNNEL WORK OF THE PENNSYLVANIA RAILROAD UNDER THE EAST RIVER.

Alarming accounts of danger and disaster in the tunnel work of the Pennsylvania Railroad under the East River at New York City are being given by the newspapers. The reports vary in character, but they all convey the general impression that the work has met such difficulties in the way of loss of life by caisson disease and stoppage of operations by blowouts that it may have to be abandoned or at least taken up anew under entirely different plans. It may be said at once that these conclusions are not warranted by the conditions that exist. There has been an unusual amount of caisson disease and one fatal accident due to a blowout and inrush of water flooding the tunnel, but the progress of excavation has been satisfactory, and there is no thought on the part of the engineers of any radical change of plans in construction.

EAST RIVER TUNNELS.—The main structural features of the East River Division of the Pennsylvania Railroad tunnel extension to Manhattan and Long Island were described in our issue of Oct. 29, 1903. Beginning at the Manhattan end of the work, there come first two three-track tunnels, one on 32d St. and one on 33d St., extending from near Seventh Ave. to Fifth Ave., 1,622 ft. At Fifth Ave. each tunnel structure changes from a single wide arch, covering three tracks, to twin arches constructed in one excavation with a masonry dividing wall separating the two tracks. This construction extends to First Ave. Here each tube begins to be constructed separately, a rock core being left between the two tubes of the same tunnel. This construction continues to the shore shafts of the river tubes, which are about 3,575 ft. from Fifth Ave. Under the river the two tubes of each tunnel continue as shield driven cast-iron lined tunnels, and the lines of the two pairs of tubes gradually converge until they meet in an open cut approach on Long Island. The cast-iron lined tubes cease, of course, at the shore shafts on the Long Island side; from here to the open cut the tubes are masonry lined.

The portion of the work outlined to which we shall refer here is the two twin-tube shield-driven tunnels under the East River. Each tube of these tunnels is 23 ft. in diameter inside the shell of the cast-iron lining. Inside the cast-iron lining there is a 2-ft. thick ring of concrete, so that the clear diameter of the tunnel inside is 19 ft. These tubes are constructed between shafts located on the river banks, two shafts, one on each shore, for each pair of tubes. The work is being done under compressed air with eight shields, four working from each shore. Some account of the compressed air plant will be given in a future issue; this article will describe the shields being used and the arrangements provided for the examination and care of the compressed air workers.

PROVISIONS FOR COMPRESSED AIR WORKERS.—The contractors for the tunnel work being considered are S. Pearson & Son,

S. PEARSON & SON, Inc.

32nd Street & First Avenue, New York, _____ 190

Name _____ Race _____ Age _____

Residence _____ St

Sight _____ Hearing _____ Ht _____ Wt _____

Muscular Development _____

Heart: Valves _____

Impulse _____ Apex _____

Pulse _____ Rhythm _____

Respiration _____ per minute _____

ACCEPTED. REJECTED.

_____ M. D.

Medical Officer.

Front.

Name _____

Nationality _____

Have you ever had Rheumatism? _____

Are you subject to catarrh, coughs or colds? _____

Have you any ear trouble? _____

Have you ever had heart, kidney or liver disease? _____

Do you, or have you ever spit up blood or have nose-bleed? _____

Have you ever had venereal disease? _____

Do you suffer from shortness of breath, dizziness or faintness? _____

Have you ever had any severe injury to the head? _____

Have you ever worked in compressed air? _____

Have you ever had compressed air illness? _____

Before accepting employment, I acknowledge that the risks incident to the work under air pressure were fully explained to me, and I agree to accept such risks and to comply with all the rules of the Company while working in compressed air.

Signature of Employee _____

Reverse.

FIG. 1. REDUCED FACSIMILE OF CARD FOR RECORDING PHYSICAL EXAMINATION OF APPLICANTS FOR COMPRESSED AIR WORK.

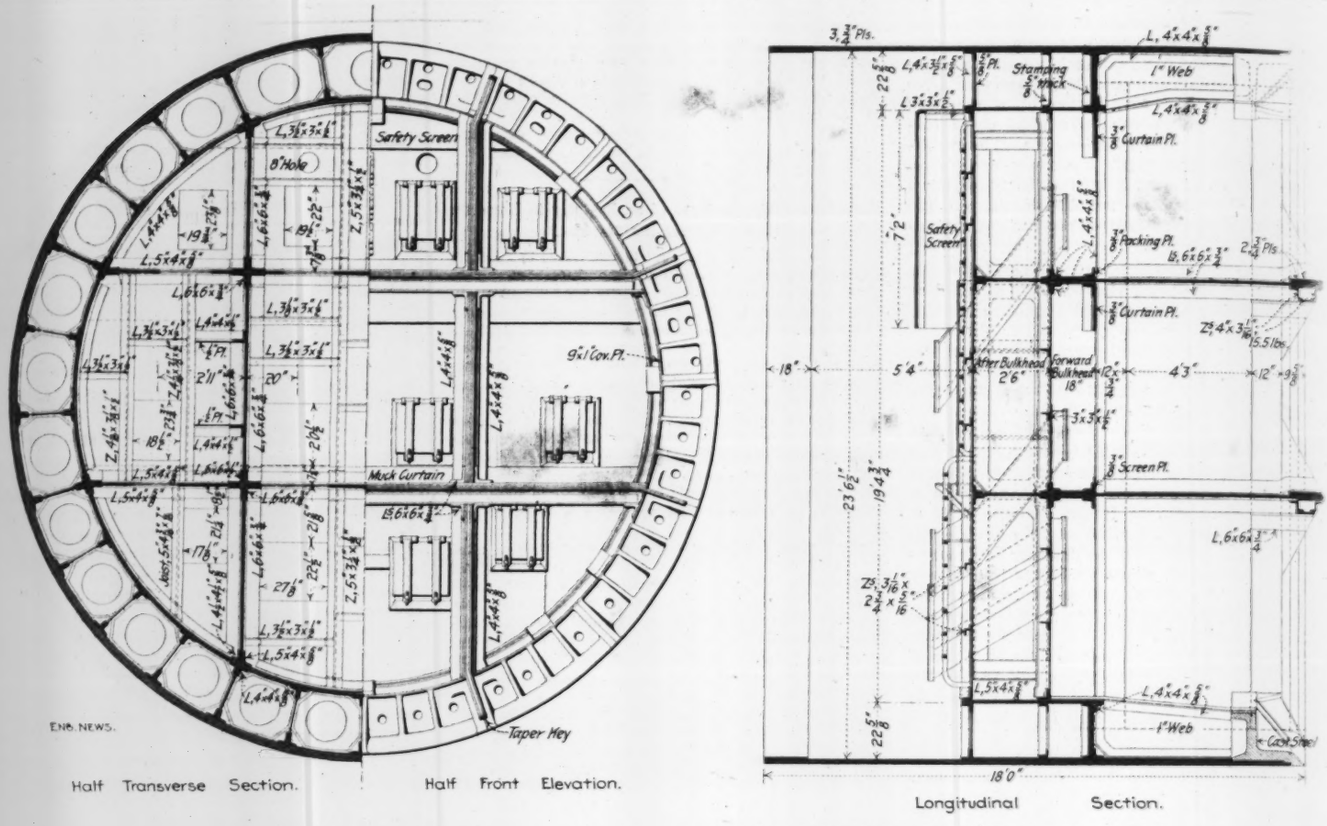
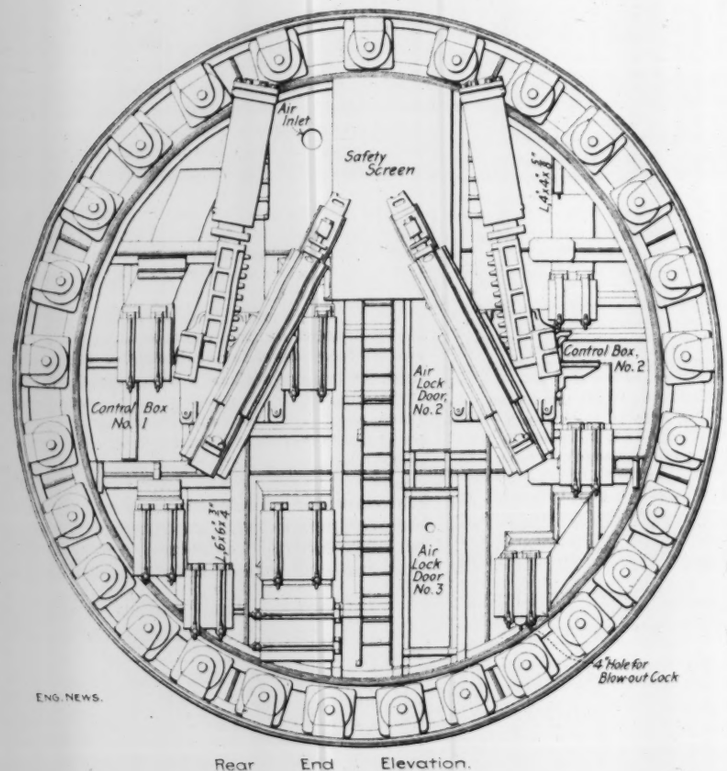


FIG. 2. DETAILS OF SHIELDS FOR EAST RIVER TUNNELS, PENNSYLVANIA R. R.



Inc., of England. Their provisions for the men working in compressed air comprise first a physical examination to determine their fitness to endure the abnormal conditions, and, second, the provision of physicians and equipment for treating cases of caisson disease and injuries. In brief, there are provided compressed air hospital locks, lockers, baths, cots, refreshment counters, medicines and medical attendance, all without expense to the workmen. The equipment is the same on both sides of the river, in fact, the working plants outside of the shafts on the two shores are exact duplicates in all respects except in arrangement.

Applicants for jobs in compressed air have first to go before the attendant physician, who makes a physical examination and questions them as to their habits and health. The character of the examination is indicated by the examination blank reproduced in Fig. 1. These blanks, when filled out, are filed and kept on record. In case the applicant answers the requirements on this blank satisfactorily and signifies by signature his acceptance of the agreement printed on the reverse side, he is given a preliminary trial by being subjected to an air pressure of 20 lbs., and examined and questioned as to its effects. If this final examination is considered satisfactory by the physician, the man is enrolled and given a numbered badge of metal, which he must exhibit in passing into the locks, and without which he cannot get admittance. In addition to the questions asked the applicant, he is given warning and instruction as to abstinence from alcoholic liquors, as to diet and time of eating, as to rest, and as to regularity of habits and general physical care of himself.

After the workman is once on the job the task of the contractor is simply that of providing, so far as is possible, for his health and for his care in case of accident or of attack by caisson disease. Both preventative and remedial measures are adopted. It is found, for example, that some of the men who have passed the medical examination for fitness and have received badges will give these badges to substitutes who have not been examined and who enter the work without the cognizance of the contractor. No remedy for this risk is open to the contractor except the personal acquaintance of the timekeepers with the men, and this is only a partial remedy. Again it is found that the men will come to the work without having eaten; to remedy this risk a luncheon is furnished each man free on request, so that he need never begin work on an empty stomach. Another risk that is encountered is haste in passing the air locks; to remedy this, outside lock tenders are employed to lock the men through so that the change in pressure is made with sufficient deliberation to be harmless. Even with this precaution it is found that some of the men will contrive undetected to steal through the material locks on the material cars. In a word, the preventative measures against caisson disease consist first in ensuring, so far as is possible by physical examination and trial under moderate pressure, that only men of robust health and temperate habits are employed, and, second, in removing every reason for disobedience of the rules laid down for their protection and welfare.

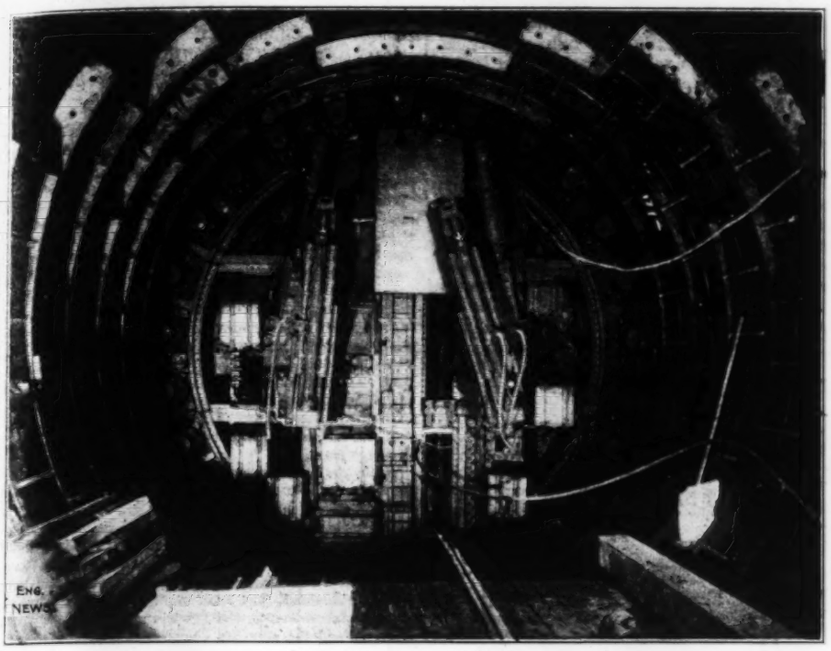


FIG. 3. REAR VIEW OF SHIELDS FOR EAST RIVER TUNNELS.

Turning now to the remedial measures, these consist of free medical treatment by a physician in constant attendance and provided with adequate apparatus and medicines for his work. The principal apparatus consists of hospital locks; there are seven of these, three on the Manhattan side and four on the Long Island side. Two of these locks, one on each shore, are reserved for the railway company's engineers. There are also separate baths, lockers, refreshment counters, etc., for these employees. Of the five hospital locks for the workmen, two are located on each shore at the shafts, and the fifth is located at East Ave., Long Island City, for the land tunnel employees. Each hospital lock is a full size man lock of regular construction, except that it is divided by a vertical diaphragm into two compartments, so that the attending physician can go to and leave his patient without changing the pressure on him. The rear compartment is the hospital compartment proper and is equipped with two spring cots, blankets, etc.

In addition to the hospital locks there are tub and shower baths. The tub bath with hot water is used and is generally found efficacious for mild cases of bends, while the shower baths are used for cleanliness solely. Generally the men take a shower bath and make an entire change of clothing upon coming from the tunnel, and usually they partake of coffee and perhaps a light meal, all of which are furnished without charge. Each man also has the use of a steam dried locker for his clothes and personal belongings. In the physician's office there is also kept a stock of medicines, bandages, etc. The company employs five physicians, who take turns on duty, so that at all times during the 24 hours there is competent medical attendance immediately at hand. Long cases of illness resulting from accident, or the after effects of caisson disease, are, of course, not cared for at the contractors' hospital; these cases are sent to one of the city hospitals for treatment.

From the preceding account it will be seen that the contractor's provisions for the comfort and health of his workmen are unusually complete. To counterbalance this fact, however, is the fact that the conditions under which the men work are at best very trying. The temperature in the headings is between 85° and 90° F., and the pressure is from 32 to 34 lbs. On the other hand the ventilation is excellent since some 5,000 cu. ft. of air per minute are being forced into the tunnel by compressors; this air, moreover, is taken from above the roof of the power-house; is not, according to analysis, excessively burdened with carbonic acid gas, and is pretty well freed from dust by the processes of compressing and intercooling. With from 30 to 45 men working in the heading there is no lack of fresh air nor is this air particularly contaminated, but it is very hot.

Turning now to the effect of the compressed air work on the men it has to be noted that attacks of caisson disease are numerous, and that so far 14 men have died of this malady. To account for this serious record by the conditions of work alone is difficult. The men work six hours a day in two shifts of three hours, with a three-hour rest between, in pressures above 32 lbs., and eight hours a day in pressures under 32 lbs. These are fairly long hours but not long enough to account of themselves alone, for the disease rate noted. The managers of the work believe that the explanation is to be found in the facts that the class of labor so far obtained has averaged rather low and that the men take foolhardy risks.

SHAFT CONSTRUCTION.—The contract for building the four East River tunnels was awarded to S. Pearson & Son in March, 1904, and about a year was spent in installing the power plant and the plant for handling spoil and materials. The sinking of the shafts was begun early in 1905. There are, as stated, four shafts, one on each shore for each pair of tubes. Each shaft consists of a steel caisson, 74 ft. 2½ ins. × 40 ft. 2½ ins. cutting edge measurement, with an inner and an outer shell 4 ft. 11 ins. apart, filled between with concrete as the sinking progressed. In the sides of the caissons in the lines of the tubes the regular wall construction was replaced by circular steel plate diaphragms 24 ft. 7 ins. in diameter. The diaphragm plates were ¼ in. plates stiffened by horizontal plate girders 36 ins. deep.

The sinking of the caissons on the Manhattan shore proved a simple operation. Rock was struck at a depth of about 50 ft., on which the cutting edges were brought to a seat and sealed. The remainder of the work was ordinary shaft-sinking through rock. The diaphragm plates were of course not removed. When the shafts had reached grade the shields were erected at their bottoms and the headings started. It should be noted that the Manhattan shafts are being used both for the river tunnel headings and for the inshore work on the land tunnel approaches; they are, therefore, divided on a plane at right angles to the tunnel lines and one-half of each is used by S. Pearson & Son and one-half by the United Engineering & Contracting Co., which is doing the land tunnel work. Each contractor has separate hoisting plants in his half of the shafts. These plants are of the ordinary character for open shaft work.

On the Long Island shore both shaft caissons were sunk the full depth of 10 ft. below tunnel grade, the rock being seamy and water bearing, and the last 30 or 40 ft. were sunk under air pressure. When the caissons had reached their final position a concrete bottom or invert was put in under air pressure. This permitted the roofs of the working chambers to be removed, which was done, and the shields lowered and

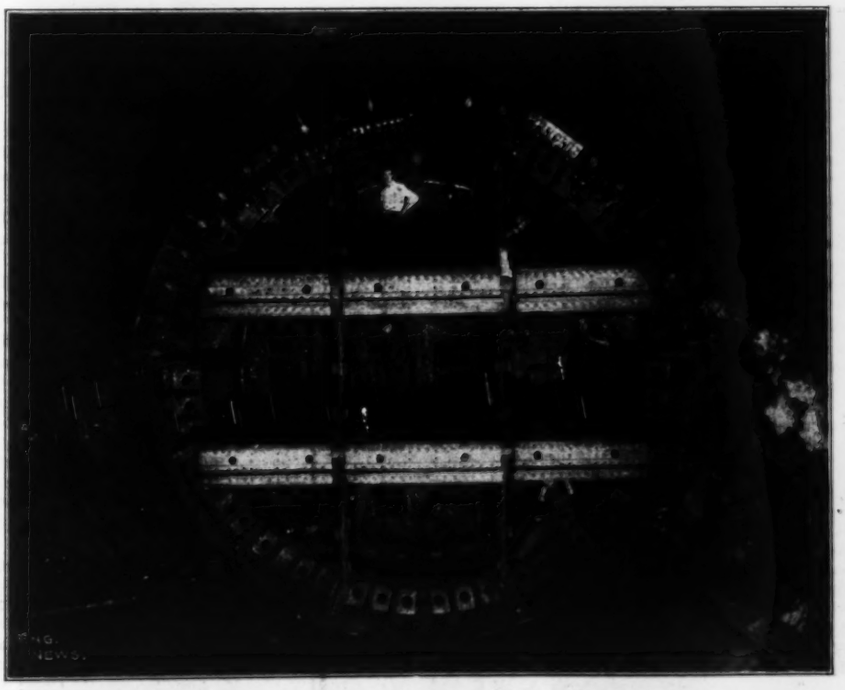


FIG. 4. FRONT VIEW OF SHIELDS FOR EAST RIVER TUNNELS.

erected and the air locks lowered. The working chamber roofs were again placed, but higher up, so as to clear the diaphragm openings, and through them vertical 6-ft. steel shafts were carried up to about 18 ft. above ground, or to working platform level, where a horizontal shaft was attached to form a Tee with an air lock in each projecting end, and a stuffing box for a hoisting cable directly above the center of the vertical shaft. At present the shafts have been completed for one caisson, that for the southernmost pair of tubes, and the air pressure has been laid on, the pressure being about 18 lbs. The headings have also been started, that for the southernmost tube being something over 50 ft. out, but the shields have not been started. On the other caisson the shafts and air locks are not yet quite completed. The steel T-shafts described are only temporary; as soon as the shields have advanced into the headings and the bulkheads have been built and air locks installed in them the temporary shafts and present working chamber roofs will be removed.

SHIELD CONSTRUCTION.—The construction of the shields for driving the river tunnels is shown by Figs. 2, 3 and 4. The novelty of the design is the transverse division of the shield by two diaphragms so as to form an air lock 2½ ft. long between the front and the tail spaces. The idea of this is to enable a higher air pressure against the face in front of the shield than behind the shield. The air lock space and the working space in front are divided into three working levels by two horizontal partitions and these again are divided into nine working chambers by two vertical partitions. On each working platform there are doors through the air lock for the men, and for each working chamber there is a spoil chute through the air lock with airtight doors at each end. The main dimensions of the shields and their structural details are indicated by the drawings of Fig. 2.

To drive the shield forward there are 27 hydraulic jacks, with 9 in. × 3½ ft. plungers, having a total capacity of 4,050 tons, with a working pressure of 5,000 lbs. per sq. in. It will be noted that the spacing of the jacks is closer on the lower half of the perimeter. The jacks are operated in pairs by valves, one for each pair, located in a controller chamber attached to the rear diaphragm of the shield. On this same diaphragm are mounted two hydraulic segment erectors. Each erector consists of two hydraulic cylinders, one fixed and thrusting downward and one mounted on a gudgeon so that it will swing in a vertical plane parallel to the diaphragm. The plunger of the fixed cylinder operates a rack which meshes with the toothed hub or sleeve by which the pivoted cylinder is mounted on its gudgeon. In brief, by advancing or withdrawing the plunger of the fixed cylinder the movable cylinder is swung on its pivot; thus, in operation, the pivoted cylinder is swung downward to receive a lining segment from the push car on the bottom, it is then swung back into the proper radial position of this segment in the lining, and, finally, the movable cylinder plunger is advanced, pushing the segment into position for bolting. The erector cylinders operate under 2,000 lbs. per sq. in. pressure, and each is controlled from a separate central box.

SHIELD WORK.—To understand the shield work it is necessary first to review the subaqueous conditions under which the work is being done. In brief, the bed rock underlying the river has the surface contour of a very flat W; the tunnels are in rock near each shore and at the middle of the river, but between these ridges of rock they are in a very fine water-bearing sand which fills the valleys and is overlaid with silt and interspersed with thin sheets of clay. Where the water is deepest, in the valleys, the tunnel roof comes within about 10 ft. of the surface. At these places a blanket of clay about 18 ft. thick and 350 ft. wide has been deposited to reinforce the cover.

The state of work at present, considering the Manhattan headings only and designating the four tubes from north to south as A, B, C and D, is as follows: Tube A is advanced something less than 100 ft. and is still in fairly solid rock; tube B is advanced about 550 ft. and has left rock and is in sand; tube C is just emerging into water bearing material about 200 ft. out, and tube D is advanced about 600 ft. and is in soft material.

In the soft material the process of work is as follows: The upper portion or roof of the shield is enveloped with a hood which can be slid forward independently of the shield; and at each horizontal platform there is a similar sliding platform. The edge of the hood and the edges of the sliding platforms are kept close against the face; the face is also lagged with steel plate shutters held against it by jacks. Openings or doors in the shutters provide for the excavation of the face. As the face is gradually broken down and removed the hood and shutters are kept thrust ahead and the shield is moved up; the rate of progress is about 5 ft. every 24 hours.

The chief difficulties in prosecuting the work are the prevention of blowouts and the resistance to the movement ahead of the shield. In the matter of blowouts, however, lies the greatest trouble experienced so far. The shield being 23½ ft. in diameter the water pressure to be resisted is something over 10 lbs. per sq. in. greater at the bottom than at the top. The significance of this is of course that if all inflow is to be resisted at the bottom, then an excess pressure of 10 lbs. will exist at the top, or if the pressure at the top is exactly balanced, there will be a deficiency of pressure and a consequent inflow at the bottom. Just where to aim between the two horns of the dilemma is the duty of the heading foreman to decide. As a rule he equalizes the pressure at the center of the shield, the resulting inflow of water being taken care of by pumps and the resulting leakage of air being made up by the compressors. There have been a number of blowouts, one of which in tube D, on June 22, partly flooded the tunnel and drowned two men. In most cases, however, it has been possible to check the blow-out short of danger to the men and work by means of hay and sand bags.

The fine water-bearing sand through which the shields work is exceedingly dense and hard when confined, but when unconfined is a quicksand. Safety in working necessitates every precaution to keep the sand confined and the result is that it becomes a task of magnitude to advance the shield. The shield weighs 250 tons and has a cylindrical area of 1,331 sq. ft., and every ounce of the 5,000 lbs. hydraulic pressure on the 27 jacks is needed to push it ahead; at times the jack pressure to accomplish an advance has reached 4,455 tons. There has been no trouble so far from plunging of the shield; in operation the shield is given a tilt upward by advancing the bottom jacks further than the top jacks.

As much has been said in the newspapers about subsidences and collapses a few closing words on this feature may be desirable. The facts are not at all alarming. The tubes pass under a brick ferry house founded on piles on made ground. There has been enough settlement to crack the brick walls in places, but this settlement has ceased. A fender rack over tube D has sunk in the middle and had its piles tilted; this is now being repaired by pulling and redriving the piles. Over the points where the shields are at work the escaping air causes "boils" of some magnitude, but beyond a local disturbance of the river bottom, stated to be unimportant by the builders, these signify nothing. In a word, the East River tunnel work of the Pennsylvania R. R. is progressing as favorably as was anticipated by the engineers.

The information from which this account of the work described has been prepared has been obtained by a personal inspection of the plans, working plant and method of operation by one of the editors of this journal. For the privilege of this inspection credit is due to Mr. Samuel Rea, Third Vice-President, Pennsylvania R. R., Mr. Alfred Noble, M. Am. Soc. C. E., Chief Engineer, and S. Pearson & Son, the contractors.

COAL TAR PAINT.*

By A. C. Cunningham, M. Am. Soc. C. E.†

While on the New Orleans naval station the writer's attention was frequently attracted by the fact that vessels of the Southern Pacific steamers entered the port of New Orleans, their hulls, from the water line for a considerable distance up, were painted with common coal-tar. Further inquiry developed the information that coal-tar was quite commonly used on the bottom of craft in the New Orleans section.

There is a general belief that the acids in coal-tar are injurious to iron or steel, and a tradition that they can be neutralized by the addition of lime. The fact that raw coal-tar is practically non-drying is well known.

Coal-tar is used with great success in coating cast-iron pipe, most generally under the name of the "Angus Smith Coating;" in modern practice, however, this coating is really coal-tar, thinned occasionally with linseed oil when continued use makes the bath too viscous. The success of coal-tar on cast-iron pipe is due to the fact that the iron is dipped into a warm bath and is at a black heat; these conditions drive off all the volatile matter and the tar becomes a lacquer. Pipe so coated will appear as fresh as new after being buried in the soil for years.

While the common coal-tar was under observation and inquiry, a patented coal-tar paint was offered for sale on the station at 50 cts. per gal.; the paint had the appearance of a high-grade asphaltum paint. Examination of the formula by which the paint was made showed that it consisted of coal-tar with some twenty different substances added in various proportions, evidently in no scientific manner, but after a "cut and try" method. The substances constituted two groups, one of which was a driver and the other an acid neutralizer.

With this information as a basis and the tradition that lime would neutralize coal-tar, a series of experiments were made to develop a paint, using turpentine as a dryer. The experiments were a failure. It was found that the lime, whether quick or slaked, spoiled the mixture, and the result was a non-lustrous coating of no durability. In the next series of experiments Portland cement was substituted for lime, the turpentine still being used; an improvement in results was secured, but the paint was not entirely satisfactory.

At this stage of the proceedings information was received that common kerosene oil would act as a dryer to coal-tar, and another series of tests was started on this basis, and the desired results were reached. Since the writer left the New Orleans Naval Station the mixture has been applied to the bottom of the floating dry dock, and the next self-docking will give an idea of its value for under-water work. The final mixture was tested by the Government chemist at the Washington Navy Yard, and pronounced non-injurious to iron and steel. The tests of the mixture were carried still further by the writer while stationed at the Naval Academy, and a perfected method of mixing developed.

The proportions of the mixture are slightly variable, according to the original consistency of the tar, the use for which intended, and the climate in which used. In general it will vary between the following proportions, by volume:

	Coal tar.	Portland cement.	Kerosene oil.
New Orleans mixture.....	8	1	1
Annapolis mixture	16	4	3

The Portland cement should be first carefully stirred into the kerosene oil, forming a creamy mixture; this mixture is then carefully stirred into the coal-tar. For the best results it should be freshly mixed and kept well stirred.

With this tar paint old, leaky tin roofs at the Naval Academy, on buildings that were to be torn down in the course of two or three years, were made watertight; on the worst places a coat was applied, then muslin was stretched over the wet paint, and, after drying, an additional coat of paint applied over the muslin. Temporary sheds that were covered with tin taken from demolished buildings had their roofs made watertight and sightly. This coal-tar paint is the only mixture that the writer has ever found that will unquestionably stick to and thoroughly cover galvanized iron.

The cost of this paint will vary from 10 to 15 cts. per gal., and when it is considered that even a "fair" linseed-oil paint will cost from 80 cts. to $1 a gal., the great economy is apparent.

Linseed-oil paints have no durability in salt water or in a very salt atmosphere, on account of the solvent action between the salt and linseed oil. The tar paint, however, being composed of purely mineral materials, is quite stable and much more durable under the same conditions. Red-lead paint is an exception to the ordinary linseed-oil paints as regards durability. Ordinary oil paints dry by atmospheric oxidation from the outside in, assisted by the dryers or oxidizers that are added and whose ultimate effect is the shortening of the life of

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the paint. The red-lead paint is dried by the oxidizing action of the red lead itself, and the resulting coat resembles to some extent an amalgam, and is very hard and durable.

After a series of experiments on the New Orleans floating dry dock, the writer found the following proportions to give the best results in red-lead paint:

Red lead, lbs.	100
White zinc, lbs.	20
Raw linseed oil, gals.	5
Turpentine Japan, pints.	3¾

This should be used the same day that it is mixed, and if passed through a common hand paint mill after being mixed as well as possible by stirring, will be all the better.

For three-coat work on a clean, new surface, the best results will be had by using 60 lbs. of lead in the first coat, 80 lbs. in the second, and 100 lbs. in the last.

The white zinc prevents the paint from "crawling," and the raw oil is used on account of the intensely drying property of the red lead. Boiled linseed oil is used in ordinary paints on account of its being already partially oxidized and thus drying more quickly. The glaring red of red lead may be modified by the addition of a slight amount of lamp black without injury to the paint.

Ready-mixed red-lead paints are a snare and a delusion. A true red-lead paint will harden in a few hours in a vacuum, and in consequence a ready-mixed red-lead paint has had the oxidizing property of the red lead destroyed and is reduced to the status of a common linseed-oil paint. True, red-lead paint will cost from $1.50 to $2 a gal., but if properly mixed from pure materials, carefully applied, and covered with a protecting coat of good common linseed-oil paint whenever it begins to show through, will last for many years. The purity of paint materials is a subject in itself, but as regards the coal-tar paint, the materials are so inexpensive in themselves that no adulteration need be feared.

It goes without saying that a metallic surface that is to be painted should be as clean and free from scale as possible. New iron from a mill is generally painted too soon, as the mill scale is very tenacious for a long time, but will ultimately come off and bring the paint with it. A rust scale is as bad to paint over as mill scale. A light newly-formed rust is not injurious to paint over, provided there is not too much for the paint to reach the metal proper. The theory that when any rusted surface is painted over the oxidation will continue on into the metal without extraneous assistance, is, on the face of it, erroneous, as iron oxide is a very stable combination. The conditions for rusting require the presence of both air and moisture; in dry air or pure water iron will not rust. Painting over a rust scale insures the contact of a porous layer containing both air and moisture against the pure metal, and rust scales continue to form under the most favorable conditions until the swelling of the oxide causes the whole to fall off. The black surface which then appears is sometimes mistaken for the mill surface of the metal.

The writer makes no unusual claims for coal-tar paint, but believes that it is better than most cheap paints of unknown origin and materials. It has been sufficiently demonstrated that it is of some value, its low cost is attractive, and in emergencies it might be of great use.

CALVIN W. RICE.

We present herewith a portrait of Mr. Calvin W. Rice, who has just been elected by the Council to the Secretaryship of the American Society of Mechanical Engineers, to succeed Prof. F. R. Hutton, who has served the Society as its Secretary for nearly a quarter of a century. Prof. Hutton will continue as Secretary until the close of the present year; but Mr. Rice will be in charge as Assistant until that time. We gave an account of Mr. Rice's professional career on page 24 of our last week's issue, but omitted to state that he was for a year or more associated with the Westinghouse interests as General Manager of the Nernst Lamp Co.

Mr. Rice has been actively interested in engineering society work in connection with the American Institute of Electrical Engineers as well as the Society of Mechanical Engineers. He served as Vice-President of the Institute in 1904-1905.

THE GREENWICH OBSERVATORY IS SERIOUSLY affected by the new main power-station of the London County Council electric railway system. The power-station is about half a mile distant from the observatory and almost due north. It is to have an ultimate capacity of about 50,000 HP., but only part of the machinery is yet installed and not more than 3,000 HP. is generated at the maximum; vertical engines are used. The vibration produced by the engine is noticed strongly at the observatory. The instrument most particularly affected up to the present is a portable transit used for longitude work. Trouble is also caused by the smoke and hot gases issuing from the stacks of the power-station, which give rise to disturbing refraction effects. An investigation is to be made by the British Admiralty and the London County Council to determine the nature and degree of the disturbance and how it may be remedied.

A CREMATORIUM in the city of Washington, D. C., was authorized by an act of Congress approved on April 29, 1906. The act provides that the crematorium be built and operated by the Commissioners of the District of Columbia, at the joint expense of the District and of the United States, and appropriates $15,000 for construction, and for operation until June 30 next following its completion. All dead bodies of persons who die from smallpox, Asiatic cholera, typus fever, the plague, leprosy, glanders, scarlet fever, diphtheria, or epidemic cerebro-spinal meningitis, provided the disposal of such bodies falls on the District, must be incinerated, and the crematorium must be large enough to burn all bodies the disposal of which is a public charge, and also "such

Calvin W. Rice

other bodies as may be presented for that purpose by the persons having custody thereof." In the latter case the Commissioners may charge fees prescribed by them, but they may "waive or reduce" the fees if they would be "burdensome or oppressive."

TANK LOCOMOTIVES of interesting design have recently been added to the equipment of some European railways. The Great Western Ry., of England, like all English railways, makes extensive use of tank locomotives of various classes for suburban service, and also for local and branch line service, the two latter including freight as well as passenger trains. Owing to the increase in weight of trains some of the older engines are being enlarged, several of the 4-4-0 class being converted to the 4-4-2 class with larger coal bunkers behind the cab. Several large engines of the 2-6-2 and 4-4-2 classes have been built at the railway company's shop to recent designs of Mr. G. J. Churchward, Locomotive Engineer. For the Alsace & Lorraine Railways, of Germany, a number of large tank engines of the 4-6-4 class, on the De Glehn four-cylinder compound system, have been built by the Societe Alsacienne des Constructions Mecaniques. The leading dimensions of the three classes of engines noted are given below:

Railway.	Gt. Western.	Gt. Western.	Alsace & Lorraine.
Class	4-4-2	2-6-2	4-6-4
Driving wheels.	6 ft. 8½ ins.	5 ft. 8 ins.	5 ft. 6 ins.
Wheelbase, driv.	8 ft. 6 ins.	14 ft. 9 ins.	15 ft. 0 ins.
Wheelbase, total.	32 ft. 0 ins.	31 ft. 0 ins.	34 ft. 8 ins.
Cylinders, h. p.	18 × 30 ins.	18 × 30 ins.	(2) 13½ × 25¼ ins.
Cylinders, l. p.			(2) 21¼ × 25¼ ins.
Heating surface, tubes	1,397 sq.ft.	1,397 sq.ft.	1,207 sq.ft.
Heating surface, total	1,518 sq.ft.	1,518 sq.ft.	1,315 sq.ft.
Grate area	20.3 sq.ft.	20.3 sq.ft.	21 sq.ft.
Steam pressure	195 lbs.	195 lbs.	225 lbs.
Weight on drivers	37 tons	54 tons	41½ tons
Weight, total	75 tons	72 tons	83¾ tons
Coal	.....	3 tons	.....
Water	.....	1,800 gals.	.....

AN ELECTRICAL SHOVEL OR EXCAVATOR has recently been equipped by the Vulcan Iron Works, of Toledo, Ohio, and has given satisfactory results, although it had been predicted that the constant and sudden stopping and starting of the motors would be injurious to the electrical machinery. The machine had a 1½-yd. dipper or bucket and was equipped with a 75-HP. motor for hoisting, a 35-HP. motor for the boom and a 25-HP. motor for swinging. Direct current motors were used and circuit breakers were placed just above the starting boxes, in addition to fuses to protect the motors in the event of the dipper being stalled. The machine worked as easily and had as great a capacity as a similar shovel worked by steam in the usual way.

PERSONALS.

Mr. F. L. Osmer has been appointed City Engineer of Aberdeen, Wash.

Mr. H. E. Rhoades has been appointed Division Engineer of the Illinois Central R. R., at Freeport, Ill.

Mr. C. N. Adkison, of Kansas City, has been appointed General Manager of the Gainesville & Gulf Ry.

Mr. W. R. Beaupre, Superintendent of the Montgomery Division of the Louisville & Nashville R. R., has resigned.

Mr. J. Bertram Young has been appointed Chemist of the Philadelphia & Reading Ry. to succeed Mr. Robert Job, resigned.

Mr. E. C. Gardanier, of Salt Lake City, has been made Superintendent of the Dominion Copper Co.'s mines at Phoenix, B. C.

Mr. William W. Locke, Assoc. M. Am. Soc. C. E., has been engaged to investigate and report upon the typhoid fever epidemic at Charlotte, N. C.

Mr. Julius H. Fulcher has been appointed Assistant Engineer in the U. S. Lighthouse Service, and assigned to duty on Lightship No. 49, off Cape Charles.

Mr. John Hall has been appointed Division Engineer in charge of construction work on the Cairo Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. A. E. Kemmer, Engineer of Construction for the Chicago, Indianapolis & Louisville Ry., was married June 26 to Miss Blanche E. Sweeney, of Lafayette, Ind.

Mr. J. H. Wallace, Engineer of Maintenance of Way of the Southern Pacific Ry., has been appointed Assistant Chief Engineer, and the former position has been abolished.

Mr. P. L. Forcardi has resigned his position with J. G. White & Co., of New York City, to accept a position with the New Jersey Foundry & Machine Co., of New York City.

Mr. F. G. Pettibone, General Superintendent of the Gulf, Colorado & Santa Fe Ry., has been promoted and made Vice-President and General Manager to succeed Mr. W. C. Nixon.

Mr. William T. Noonan has been promoted from General Superintendent to General Manager of the Buffalo, Rochester & Pittsburg Ry. and the office of general superintendent is abolished.

Mr. J. B. Lippincott, Supervising Engineer of the Pacific Coast District of the United States Reclamation Service, and Hydrographer of the United States Geological Survey, has resigned.

Mr. Herbert M. Knight, Office Engineer of the Baltimore Sewerage Commission, has been promoted to Division Engineer of Stormwater Drainage to succeed Mr. George T. Hammond, resigned.

Mr. A. A. Talmage severed his connection with the Blaisdell Co., of Los Angeles, Cal., as Secretary and Manager, July 1, to become associated with the Securities Corporation, Ltd., of New York City.

Mr. George C. Towle, formerly Engineer of the Bay Road Construction Co., of Syracuse, N. Y., has been appointed General Manager of the People's Street Railway Lines of Dayton, Ohio, to succeed John L. Breen, deceased.

Mr. Frederick W. Green, Superintendent of the Memphis Division of the Iron Mountain Ry., has been appointed General Superintendent of the Louisiana & Arkansas Ry., with headquarters at Wynne, Ark. Mr. Homer L. Hungerford will succeed Mr. Green.

Mr. L. H. Gardner, formerly Engineer for the National Packing Co., has opened offices in the First National Bank Building, Omaha, Nebr., as a Consulting Engineer. He will give special attention to water-works, light and power plants and power transmission.

Mr. L. T. Maenner, Chief Draftsman in the Engineering Department of the Chicago, Rock Island & Pacific Ry., has been appointed Chief Draftsman in the Engineering Department of the Panama Canal, with headquarters at Culebra, Panama. Mr. Maenner sailed from New York on July 3.

Mr. Olaf Sangstad has opened offices at 13 Park Row, New York City, where he will practice as Consulting and Designing Engineer. He will make a specialty of tem-

perature and pressure regulation. Mr. Sangstad was formerly connected with the Davis & Roesch Temperature Controlling Co. and the H. & M. Automatic Regulator Co.

Mr. D. W. Bolich has been appointed Superintendent; Mr. Jos. Little, Assistant Superintendent; Mr. W. D. Waltman and Charles Sharp, Supervisors of the Department of Excavation of the Isthmian Canal Commission. This department is a consolidation of the Mining Department and the Excavation Department of the Culebra Division. The headquarters of the new department are at Empire, Canal Zone, Panama.

Mr. E. D. Lumsden, Assistant Engineer on the New York Long Island R. R. Co.'s tunnel under the East River, has resigned and formed a partnership with Mr. R. Y. Meacham, of Hopkinsville, Ky., under the firm name of the Meacham Engineering & Construction Co. They will do a general contracting business and make a specialty of reinforced concrete construction. Their offices will be at Hopkinsville, Ky.

The Board of Directors of the Bethlehem Steel Co. at their meeting on June 27 elected the following officers: Chairman of the Board, Mr. C. M. Schwab; President, Mr. Archibald Johnston to succeed Mr. E. M. McIlvain, resigned; Vice-President, Mr. H. S. Snyder to succeed Mr. A. E. Borie, resigned; Secretary and Treasurer, Mr. B. H. Jones to succeed Mr. H. S. Snyder, resigned; General Superintendent, Mr. E. G. Grace to succeed Mr. Archibald Johnston. Messrs. Jones and Grace were elected to the Board to fill the vacancies caused by the resignations of Messrs. McIlvain and Borie.

Obituary.

Winthrop W. Ruggles died June 30 at Jersey City, N. J., aged 74 years. He was formerly Chief Engineer of the Street and Water Department of Jersey City. He served as City Surveyor of Jersey City from 1871 to 1881, when he became one of the engineers who laid out the West Shore R. R., returning to the city's service in 1884 as Chief Engineer.

Jonas Wilder died at the home of his son, in Woodstock, Vt., aged 93 years. Mr. Wilder was born at Wendell, Mass., and when a young man was put in charge of the engineering work in the construction of the Vermont Central R. R., later becoming Superintendent of the old Rutland & Washington Division of the Delaware & Hudson R. R. His last railroad work was about 20 years ago, when he supervised the construction of a railroad at Bristol, Tenn.

George H. Robinson, M. Am. Inst. M. E., died at New York City, July 4, aged 58 years. He was born in Ohio but went West in 1878 as an engineer on the Santa Fe Railway. In 1882 he went to Montana on a Government survey, after which he became connected with the Montana Mining Co. operating the Drum Lummon Mine which he managed for the Rothschilds. He went to Utah in 1890 and organized the Tintic Mining Co., and in 1898 became Chief Consulting Engineer to F. A. Heinze. Mr. Robinson severed his connection with Mr. Heinze in 1903 and organized the Britannia Mining Co., one of the largest copper companies on the Pacific Coast, their mines being located at Howes Sound, British Columbia.

Joseph J. Woodward, Naval Constructor of the Board of Inspection and Survey, died suddenly of heart disease near Field, B. C., on a train of the Canadian Pacific Ry., July 6. Constructor Woodward was a graduate of the class of '81 of Annapolis, and had taken a graduate course at the French Government schools, the Ecole Polytechnic and the Ecole du Génie Maritime. He was an assistant constructor at the New York Navy Yard when the original Maine was built, and had to do with the designing of the Brooklyn, the Iowa and other smaller vessels. While Superintending Constructor at Newport News he supervised the building of the Kearsarge and Kentucky and other ships. He had been a member of the Board of Inspection and Survey since 1901. At the time of his death he was on his way to Seattle, Wash., to conduct the trial of the new first-class battleship Nebraska, which was built at the shipyard of Moran Bros., of Seattle.

Joseph B. Sanford, a well-known dock and railroad builder, and senior member of the firm of Sanford & Brooks, of Baltimore, Md., and New York City, died at his home at Newark, N. J., July 5, of heart disease. He was born at Colesville, N. J., in 1832, later removing to Newark. In 1851, following the first gold craze, he went to California, where he introduced Chinese labor in mining, as well as a new system of hydraulic mining. He went to Australia in 1853 and conducted several gold mining projects there. After returning to his country he formed a partnership with his brother, later becoming a partner in the firm of Sanford & Ross, who did much work building docks and doing other contracting for the Government. When Mr. Walter B. Brooks entered the firm the name was changed to Sanford & Brooks. Besides being President of the firm of Sanford & Brooks, Mr. Sanford was also Vice-President and General Manager of the Lake Drummond Canal & Water Co., of Baltimore, Md.

Charles Paine, Past-President of the American Society of Civil Engineers, died at his home in Tenafly, N. J., on July 4. Mr. Paine was born at Haverhill, N. H., April 25, 1830. He entered the service of the Vermont Central R. R. in 1845, later going with the Vermont & Canada R. R. In 1858 he became Superintendent of the Michigan Southern & Northern Indiana R. R. Six years later he became Chief Engineer of the Lake Shore & Michigan Southern Ry., and he was in the service of that company in that capacity and in the General Superintendency, to which he was promoted in 1872, for 17 years. When the West Shore Ry. enterprise was undertaken in 1881, Mr. Paine was selected as its General Manager, and the construction of that road will rank as the most notable engineering work of his career. When the West Shore enterprise met financial failure Mr. Paine went to the New York, Pennsylvania & Ohio R. R. as General Superintendent, at which time he was closely associated with the late A. M. Wellington, and also acted as Vice-President of the New York, Lake Erie & Western Ry. Shortly afterward Mr. Paine removed to New York and engaged in consulting practice. He was General Manager of the Panama R. R. Co. for many years, up to the time the line was taken possession of by the United States. Mr. Paine became a member of the American Society of Civil Engineers in 1867 and was its President in 1883. During his years of active professional work Mr. Paine was a frequent contributor to technical literature. Some of his important papers read before the American Society of Civil Engineers were: "Designing and Erection of the Oakley Arch," "Efficiency of Railroads for the Transportation of Freight," and "History of the Iron Rails Upon the Michigan Southern & Northern Indiana Railway." Some of his papers were reprinted in book form under the title "Elements of Railroading."

George Y. Wisner, M. Am. Soc. C. E., one of the best known engineers in the Central West, died at his home in Detroit, Mich., July 3, of stomach trouble. He was born at West Dresden, N. Y., July 11, 1841, and graduated from the Department of Civil Engineering of the University of Michigan in the class of '65. After graduation he entered the employ of the Government as a U. S. Assistant Engineer, and was employed for 27 years in government work and surveys on the Great Lakes; the Mississippi, Des Plains and Illinois Rivers and the tenth and eleventh Lighthouse Districts. In 1887 he resigned his Government position to engage in private practice, and he has since that time been engaged in a large number of important enterprises as a Consulting Engineer. He was Chief Engineer of the Brazos River Harbor improvement in Texas, Consulting Engineer to the Montreal, Ottawa & Georgian Bay Canal Co., and for two years past he had been one of the Consulting Engineers of the U. S. Reclamation Service. Probably the most important professional work of his lifetime was his service on the Board of Engineers on Deep Waterways between the Great Lakes and the Atlantic Seaboard. While the canal recommended by this Board has never been undertaken, the investigations and report made by the Board rank as one of the most thorough and systematic pieces of engineering work ever undertaken in this field. Mr. Wisner was also at the time of his death a member of the International Commission on the Levels of the Great Lakes. Mr. Wisner was a liberal contributor to professional literature, many of his papers having appeared in the columns of Engineering News. Among the more important papers by him appearing in the "Transactions of the American Society of Civil Engineers" are the following: "Origin of the Gulf Stream and Circulation of Waters in the Gulf of Mexico," "Reservoir System of the Great Lakes," "Economic Depth for Canals," "The Brazos River Harbor Improvement," and "The Economic Dimensions for a Waterway from the Great Lakes to the Atlantic."

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 19 to 20. Semi-annual meeting at Chicago, Ill. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 28 to Aug. 4. Joint meeting with the Iron and Steel Institute at London. Secy., R. W. Raymond, New York City.

CONCRETE BLOCK MACHINE MANUFACTURERS' ASSOCIATION.
Aug. 8, 9. Annual meeting at Detroit. Secy., S. L. Wiltse, Jackson, Mich.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 15 to 17. Annual convention at New Haven, Conn. Secy., Frank P. Foster, Corning, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
Sept. 26 to 28. Annual convention at Chicago, Ill. Secy., Jno. MacVicar, Des Moines, Ia.

STRUCTURAL ASSOCIATION OF SAN FRANCISCO.—Arrangements have been made with the "American Builders' Review" whereby they will publish a weekly supplement devoted exclusively to the researches and proceedings of the association. The meetings of May and June were devoted to perfecting organization and to committee reports. In the future the papers will be in writing to be distributed before the meeting at which they are to be read, while the programs of coming meetings will be published in the Engineering Supplement each week. Following is the proposed list of rolled steel sections representing necessary sizes in designing steel construction for buildings in San Francisco. Arranged by the committee on steel construction and design and approved by the association:

Beams.—24-in. × 100 lbs., 24-in. × 80 lbs., 20-in. × 90 lbs., 20-in. × 65 lbs., 15-in. × 60 lbs., 15-in. × 55 lbs., 15-in. × 42 lbs., 12-in. × 31½ lbs., 10-in. × 25 lbs., 9-in. × 21 lbs., 8-in. × 18 lbs.

Channels.—15-in. × 33 lbs., 12-in. × 20½ lbs., 12-in. × 30 lbs., 12-in. × 40 lbs., 10-in. × 15 lbs., 10-in. × 25 lbs., 9-in. × 13¼ lbs., 8-in. × 11¼ lbs.

Angles.—(2½ × 2 × ¼), (2½ × 2½ × ¼), (3½ × 2½ × 5-16), (4 × 3 × 5-16 to ½), (5 × 3½ × 5-16 to ½), (6 × 4 × ⅜ to ¾), (6 × 6 × ⅜ to ¾) ins.

Plates.—(8 × ¼ to ⅜), (10 × ¼ to ½), (12 × ¼ to ½), (14 × 5-16 to ⅝), (16 × 5-16 to ⅝), (30 × 5-16 to ⅝), (36 × 5-16 to ⅝) ins.

Bars.—(2½ × 5-16 to ½), (3½ × ⅜ to ¾), (3 × ⅜ to ½), (6 × 5-16 to ¾) ins.

These sections have been formulated on the basis of using material up to ⅞-in. thickness for ¾-in. rivets and up to ¾-in. thickness for ⅞-in. rivets.

THE INTERNATIONAL FIRE CONGRESS.—Among the resolutions adopted by the Congress at its recent meeting at Milan, Italy, are the following, which are of interest to Americans:

RESOLUTION I.

EXTERNAL OPENINGS TO BUILDINGS.

That the Congress recommends:—

(a) That greater attention be accorded to the protection of vertical external openings to buildings than heretofore.

(b) That some approved means of protection be compulsory for all opposing windows having less than 8 ft. intervening, and for opposing windows in enclosed courts having less than 15 ft. intervening.

RESOLUTION II.

PUBLIC BUILDINGS.

That the Congress considers that it is necessary to accord greater attention than heretofore to safety from fire in large public buildings, such as churches, museums, hospitals, colleges, etc.

RESOLUTION III.

REINFORCED CONCRETE.

(a) That the Congress considers that no reinforced concrete construction should be permissible in buildings intended to be fire resisting unless the aggregate be most carefully selected and applied in such a manner as to give substantial protection to all metal parts.

That it is advisable where reinforced concrete is intended to be fire resisting that every portion of the metal rods or bars contained therein be covered by not less than 2 ins. of concrete, the aggregate of which must be able to pass through a sieve of not more than 1 in. diameter, and that Portland cement of great fineness only be used.

(b) That where feasible all external angles should be rounded.

(c) Any angle iron needed for mechanical protection should be held in position independently of the concrete.

RESOLUTION IV.

MOTOR GARAGES.

(a) That accommodation for motor cars (motor garages) be not allowed under dwellings.

(b) That special measures for isolating motor garages from adjacent dwellings be adopted.

(c) That special measures be taken to avoid the possible access of benzine or petrol into the cellarage, drains or sewerage system of buildings.

(d) That, for the storage of small quantities of petrol or benzine, the cans be kept below ground level, but where a quantity be kept greater than can be easily removed by hand, a proper underground metal receptacle be employed from which the liquid could be extracted without the pressure of air.

RESOLUTION V.

INTERNATIONAL RELATIONS AND THE INTERNATIONAL FIRE SERVICE COUNCIL.

That the Congress considers the primary object of the International Fire Service Council to be:—

I.—The encouragement of international social relations:—

(a) With the arrangements of facilities for written intercourse between leaders of the fire fighting and fire preventive services of all countries.

(b) With the arrangements of the exchange of visits between fire brigade officers and men of different countries.

II.—The organization of international congresses and conferences on important technical fire preventive and fire service subjects at given intervals:—

(a) With the arrangement of a proper sequence of the subjects to be considered without repetition.

(b) With the arrangement of their discussion by leading authorities.

(c) With their publication on uniform lines in three languages.

III.—The maintenance of a well managed inquiry office:—

(a) At which particulars as to sources of information can be easily and rapidly obtained.

(b) Technical questions can be replied to with authority.

(c) Statistical and general information is issued at regular intervals.

RESOLUTION VI.

INTERNATIONAL STATISTICS.

(a) That the Congress considers that reliable international statistical information as to fires and fire losses is essential.

(b) That the Congress hereby requests the International Council to prepare international statistics as to fires, obtaining the necessary data wherever possible from the respective Government departments or other authorities and societies concerned.

ENGINEERING LITERATURE

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EDITORIAL.

A volume bearing the title "Biological Studies," consisting of papers written by nineteen of the pupils of Wm. T. Sedgwick, Professor of Biology at the Massachusetts Institute of Technology, has been issued to mark the twenty-fifth anniversary of the doctorate of Professor Sedgwick. A number of the papers will appeal to sanitary engineers, more particularly one, by Mr. Geo. W. Fuller, in which he describes various experiment stations for studying water and sewage disposal at home and abroad, and also one by Mr. Geo. C. Whipple, on "The Value of Pure Water." Further informaton regarding this graceful and well deserved tribute to Professor Sedgwick may be obtained from Dr. Edwin O. Jordan, of the University of Chicago, Chicago, Ill.

A Text-Book for River and Harbor Engineers.

Reviewed by D. D. Gaillard.*

A PRACTICAL MANUAL OF TIDES AND WAVES.—By W. H. Wheeler, M. Inst. C. E., Author of "Tidal Rivers," "The Sea-Coast," etc. London, New York and Bombay: Longmans, Green & Co. Cloth; 6 x 9½ ins.; pp. 201; 19 illustrations, mostly in the text. $2.80, net.

The author of this book needs no introduction to students of certain classes of tidal phenomena or to engineers engaged upon the improvement of seacoast harbors or tidal rivers, being already known to them through previous works relating thereto.

The subjects of which he treats have been handled in a thoroughly practical manner, free from mathematical demonstration; in style so clear and concise that no reader should have difficulty in understanding them.

The first chapter treats of tidal action as an aid to navigation and instances are cited showing that in many cases it is only by the aid of tides that vessels of large size are enabled to deliver their cargoes at river ports far inland.

The next chapter contains a short and admirable history of the development of tidal science from the time of Herodotus to the present day, and a brief account of the study of wave action from the time of Leonardo da Vinci. This latter account is less complete than the former, and does not include the observations upon deep-water waves, made by officers of the United States Navy, 1883-7; by Dr. Gerhard Schott, 1891-2, and Lieutenant Gassenmayr, 1895, nor the extended series of observations upon shallow-water waves, made on the South Atlantic coast, 1890-1, and on Lake Superior, 1901-3, described in Professional Papers No. 31, Corps of Engineers, U. S. Army.

Chapter III. contains a brief and clear description of the relation of the sun and moon to the earth, and the area and depth of the water surface on the globe. The chapter following relates to the generation of the tides, a subject which is treated with remarkable clearness and entirely without the use of mathematical formulae.

Chapter V. deals with the propagation of the tidal wave, both primary and derivative; the rate of propagation; the effect of expansion and contraction of the shore line; reflected tides, races and eddies; double tides; rotary tides, and diurnal inequality of tides.

The succeeding chapter treats of tidal currents and shows that they conform to the general laws which govern the flow of water in open channels. In it the author calls attention to a puzzling phase of tidal action sometimes encountered on tidal streams—the fact that, due to acquired momentum, a tidal current will in some localities continue to flow in the same direction for some time after the reversal of the slope of the water-surface, i. e., the water runs up-hill for a time. This action is very marked in the St. Johns River, Florida, where the flood current runs against a reversed gradient for over an hour before "high-water slack."

The next chapter relates to the mean level of the sea and range of the tides.

The influence of wind and barometric pressure upon the tides is discussed at length in Chapter VIII. Numerous instances are cited and tables are giving showing the effects upon tidal rise produced by gales and by variations in barometric pressure.

The chapter following, one of the most interesting in the book, deals with the important subject of river tides. In it are discussed the propagation of river tides; double flow; velocity of propagation; distance to which tides are propagated; tidal currents; transport of material, and salinity of river water. To engineers who are engaged in work upon the improvement of tidal rivers, no part of the work is more valuable than is the chapter just described, and especially interesting is the discussion of the transport of material. This subject is first treated analytically, and then are given the results of experiments made with floats to determine the average down-stream progression of the water particles along the tidal reach.

Experiments on the Thames for periods of 30-45 days showed that the average down-stream progression of the float was only about ⅛ mile per day and on the Clyde about 2.35 miles per tide. The effect of this backward and forward oscillation upon material in suspension or traveling upon the bottom is next explained, and instances of this effect cited. Attention is called to the fact that although floats give some indication of the distance solid matter will travel, yet they fail to show the movement of the finer particles in suspension, or of matter such as salt in solution, which undergo a mixing process and become diffused over longer reaches.

Chapter X. is devoted to a discussion of waves, which the author divides into two main classes: tidal waves and wind waves. Tidal waves are still further subdivided into the great primary tidal waves, tidal waves which are propagated from the primary wave, and tidal shore waves.

Wind waves are classified as:

1. The deep waves of the ocean, where unlimited depth and space are provided for the making of the wave.

2. Waves found in the smaller seas, where the depth and the fetch of the wind, are limited.

3 Rollers and ground swells.

4. Shore and breaking waves, or waves of translation.

All of these classes of waves are familiar to the student of wave action except, perhaps, "tidal shore waves," the formation of which is attributed to tidal action alone. These wavelets in calm weather are said to vary in height from 6 to 24 ins., and in length from 15 to 20 ft. Their average velocity is 4.89 ft. per second, and they break on shore at the rate of 10 to 12 per minute. Not a few engineers familiar with seacoast works will be surprised to learn of the existence of these tide-formed waves, and still more surprised to learn of the shore-molding power which the author attributes to them in stating that "as the wavelets break they become a vehicle for the transmission of mechanical force, and are capable of transporting material. It is by this agency that shingle is transported along the coast, and shingle beaches are formed." . . . "These tidal wavelets breaking on a beach are, therefore, much more powerful, and have much more effect in transporting material than tidal currents." The author states that previous to the description of these waves in his book, "The Sea Coast," they had not been recognized.

In discussing wind waves the author treats of ocean waves; size of waves; action of the wind in making waves; formation of waves; depth to which wave motion extends; proportions of waves; waves of the British seas; rollers and ground swells; breaking waves, and impact and force of waves.

Interesting as it is, the author's discussion of wind waves is upon the whole less satisfactory than is his admirable treatment of tides and seismic and cyclonic storm waves.

Engineers engaged in the construction of coast works deal entirely with waves in relatively shallow water and are concerned among other things with the velocity of such waves; their total theoretical energy; the elevation of their crests above and depression of their hollows below the level of still-water—subjects not treated in sufficient detail for their purposes in the author's discussion. It is but fair, however, to state that previous to the observations made in Lake Superior, 1901-3, full observations upon large-sized waves in shallow water were limited in number, and the records describing them were so scattered that it was very difficult to secure satisfactory data of the character indicated.

The subject of seismic and cyclonic storm waves is most interestingly treated in Chapter XI., in which the author describes earthquake waves, solitary waves and cyclonic storm waves. The method of generation of each of these classes of waves is explained and numerous instances of their destructive effects are cited.

The next chapter deals with the causes of "bores" in tidal rivers and the conditions necessary for their full development, after which follows an interesting description of fifteen of the principal bores of the world.

Chapter XIII. treats of tide tables and tide gages, and is followed by a chapter relating to "seiches," secondary undulations and undulations preceding a storm.

The final chapter contains a discussion of tides as a source of power, and in it the author shows that with existing mechanical appliances any attempt to utilize the tides as a source of power on a large scale cannot be considered as coming within the lines of commercial economics.

Following this chapter are seven appendices containing authorities consulted; velocity of propagation of tidal waves in the open ocean; tidal data at various ports; tables showing hourly rise and fall of tides, and height of tide above low water at any hour during the ebb or flood; velocity of propagation of tidal wave in rivers, by observation and by formula; proportion of ocean waves and relation of the wind to their dimensions, and a table of English and French nautical measures.

A persual of this work will convince any reader that the entire discussion of tides and tidal phenomena has been undertaken by one familiar with the subject, both practically and theoretically, and influenced by genuine love for the work. As a result the author has produced a valuable practical manual of tides and waves which should be found in the library of every one interested in these subjects.

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Phototopographic Surveying.

Reviewed by Ernest J. Sommer.*

AN ELEMENTARY TREATISE ON PHOTOTOPOGRAPHIC METHODS AND INSTRUMENTS.—Including a Concise Review of Executed Phototopographic Surveys and of Publications on this subject. By J. A. Flemer, Topographical Engineer. New York: John Wiley & Sons. London, Eng.: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. xix. + 438; 109 plates. $5.

Mr. Flemer published his first paper on phototopography in the report for 1893 of the Superintendent of the U. S. Coast & Geodetic Survey. The report for 1897 contains a second paper from the same source. These two papers contain probably the essentials of photographic methods and instruments. In the present volume, modestly styled an elementary treatise, the author furnishes a work which is fundamental in treatment and so exhaustive that it will remain for a long time what it is now: the standard book on phototopography in the English language, especially in the United States, where books on the subject are lacking to a degree.

This uniqueness will secure to the book a welcome entrance to professional libraries and the way into the hands of professors and students who will find it indispensable as a text-book on surveying alpine and other regions difficult of access, or in climates which compel rapidity of work in short field seasons. It does not, however, satisfy the urgent demand of the profession for a handbook defining principles briefly, explaining methods concisely, and describing instruments mainly by illustration or reference to trade catalogues.

It is hoped that Mr. Flemer, drawing exclusively upon his own experience, will bestow upon his confrères a handbook containing essentials only, in condensed form, for practical use, and free from all "on-the-sides." Such a handbook would prove a perfect boon in Alaska, where economic development goes apace at such rate that the older methods of surveying fail to supply the present demand for maps. The chapter on ancient (the bibliography extends back to the year 1617) and modern history of surveying, mapping, topography and kindred branches could be omitted without causing disappointment.

The effacement of the "Ego" throughout the book and the vastness of the quoted literature—in six languages and of nine countries—make it impossible for any reviewer, not personally acquainted with the author, to distinguish between original thought and the results of compilation. As it is, the book stands a monument of profound erudition and painstaking elaboration. These qualities, however, should not scare off the intending purchaser, as the book makes no unreasonable demands on the scientific preparedness of the reader.

The prefatory remarks of the author are instructive and timely; especially those addressed to the prejudice of surveyors against the new method. The table of contents is well arranged; its perusal is an instruction by itself. It does not stand to reason, however, that certain methods should come under the head of Italian, French, Canadian, etc., because of the nationality of their originator and practicer.

The book proper begins with a chapter reviewing photographic surveys done in Europe and in America north of the 49th parallel. This chapter is historic in its treatment of the origin and development of photographic surveying. The second chapter, on perspective, conveys knowledge supposed to be in the equipment of every engineer. The third chapter explains pinhole photography by text and plate and treats of diameter of aperture and focal length of camera, duration of exposure and the determination of constants.

With the fourth chapter, on iconometric plotting, the practical part of the book begins. The orientation of picture traces on the map; iconometric plotting when either camera or photo-theodolite are used; the arithmetical and graphical determination of the position of the principal point and of distance and horizon lines on the photographic perspective; the location of the camera station from known points; the elevation of the camera horizon and other problems are successively treated for vertically exposed plates. Considering the Bohnenberger and Bessel method, as stated in the solutions of the three-point problem, the query suggests itself: how can a circle be described through two plotted points and an unknown point? The solution is self-evident when the auxiliary point, on the line from the third plotted point to the station is introduced at first. The consideration of Hauck's method leads the author to introduce a new technical term: Kernel point (Kernel plane). While its German origin, Kernpunkt (Kernebene), had its established place centuries before Hauck, the present rendition in English does not seem quite idiomatic.

Means of plotting from photographic perspectives are discussed, and the chapter closes with the explanation of the vanishing scale. The following chapter treats of the same problems with reference to photographs when exposed on an inclined plane.

The chapters expounding the principles of plotting maps from photographic plates are succeeded by what is, without doubt, the most important part of the book: the employment of the camera in field work. The engineer, familiar with the principles and methods of perspective, will turn with eagerness to what our author presents in the following chapters on the new method of surveying. Beginning with the consideration of arithmetical and graphical methods of ascertaining geodetic elements from the known constants of the perspective, especial mention is made of the methods of W. Jordan, G. Le Bon and L. P. Paganini. In elucidation of the latter method some examples from actual practice are exhibited. These special methods are followed by general arithmetical methods. The author then presents the more popular because most practical method of plotting: the graphical. Laussedat's, Meyenbaur's, Legros', Finsterwalder's and Deville's methods are explained. The latter, coming under the author's nearer observation, is minutely treated in 13 sections.

The distinctive properties which camera lenses should possess are discussed in a chapter on lenses. A general knowledge of optics being in the possession of every engineer, much in this chapter might have been sacrificed to brevity. Recognizing that the value of high-grade lenses in photography is generally appreciated, the author does not dwell upon this point. Attention is called to important improvements recently made in the Zeiss laboratories. The author's description of surveying cameras and photogrammetric instruments is more than ample. Reference to manufacturers' catalogues could have saved some of the bulk. Some of the instruments described were in their experimental stage and should not have been mentioned except in their perfected model. Dr. Pulfrich's stereo-photogrammetric surveying method and the stereocomparator and the stereoscopic telemeter from the Zeiss establishment at Jena form a notable exception, in being the most recent addition to the subject under review.

What Mr. Flemer says on operations in the field is of the highest value, containing much of the authority of his own experience. What this chapter contains about negatives, exposures, solutions, developers, etc., would constitute a handbook for the photographer. The statement of weights in metric and troy terms is of decided usefulness.

The twelfth and last chapter, probably more the author's own than any other, contains general remarks on phototopography, teleophotography and the precision of the "polar-iconometric" method. The author mentions the main disadvantage of the photographic method, consisting in the necessarily slow progress of the office work. The compensating rapidity of the field work gives the method its commanding preference under certain conditions.

The book is provided with a complete index. The 198 figures on 109 plates are all from the author's excellent drawings. One more plate, showing one of the author's superb maps, made in connection with the Alaska Boundary survey, would certainly have met with favorable reception in illustration of possible results.

The printing and make-up of the book are beyond praise. The quotations in foreign languages are to a rare degree free from error. Resume for résumé, haerfuer for hierfuer, servi for servicio may be mentioned, as also archomati for achromatic. Génie corps for corps de génie is German by usage but not English. Technische Hochschule is incorrectly done into technical high school; Hochschule in Germany is equivalent to and exchangeable for University, while "high school" belongs in the preparatory class with us. On page XII. substitute 52 for the page number of Chapters IV., II., B., in the index 17 for 163 and 163 for 180 in third and fourth page number respectively. The notation is slightly defective in Fig. 21; on page 49 A is omitted in first equation, and on page 117 the equation near the top should read $\frac{D}{B} = \frac{B}{\quad}$ instead of $\frac{\quad}{B} = \frac{\quad}{D}$.

*Coast and Geodetic Survey, Washington, D. C.

Elementary Applied Mechanics.

Reviewed by Amasa Trowbridge.*

TEXT-BOOK OF MECHANICS.—By Louis A. Martin, Jr., Assistant Professor of Mathematics and Mechanics in Stevens Institute of Technology. Vol. I., Statics. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5 × 7½ ins.; pp. 142; 167 figures in the text. $1.25, net.

This is the first part of a text-book designed for an introductory course to Applied Mechanics, for use in colleges and technical schools. The author has arranged the book so that Statics only is covered in this volume, and in it makes no use of the Calculus. He also aims to make the student apply his knowledge of Algebra, Geometry and Trigonometry so as to clearly understand their use in applied mechanics.

There is, as the author says, nothing new in the subject matter of the book. The arrangement is, however, somewhat different from the ordinary and the presentation quite different. Perhaps the most striking thing in the presentation is the author's definite direction, "Draw a diagram illustrating the problem" as the first step in the solution of the problem. This is a point that is too often neglected in books on pure mathematics, it being left to the student to imagine a figure, with the result that he usually imagines a number of things, some pertinent, others absolutely without relation to the problem in hand.

Just one-half the volume is devoted to the action of forces on a single point and on a rigid body. Then the application of this to simple machines is considered, after which come Graphical Statics and their application. The introduction of graphical statics in such a book is excellent, as it materially assists the student to see the application of his theoretical mechanics to engineering problems.

A very brief appendix suggests the way by which stresses in three-dimensional structures can be found by the two-dimensional methods given in the book. There are presented for solution 255 problems, for the most part quite wisely chosen, and they add very much to the value of the text.

The book is very elementary and, as it covers a wide range of subjects, is hardly thorough enough. This last is a common defect in books on elementary mechanics, and in this the author has only followed common practice, though it is to be regretted that he did not use more space and make clearer explanations in many of the propositions. Even with this defect, the book is a very good one for class work in technical schools.

Beginning with July, 1906, "The Iron and Steel Magazine," edited by Dr. Albert Sauveur, will be consolidated with "Electrochemical and Metallurgical Industry," of 114 Liberty St., New York City. Dr. E. F. Roeber is editor of the last-named journal.

*Adjunct Professor of Mechanical Engineering, Columbia University, New York City.

The Manufacture of Iron and Steel.

Reviewed by Bradley Stoughton.*

THE PRINCIPLES AND PRACTICE OF IRON AND STEEL MANUFACTURE.—By Walter Macfarlane, F. I. C., Principal of the Metallurgical Department, Staffordshire Education Committee. London, New York and Bombay: Longmans, Green & Co. Cloth; 5 × 7¼ ins.; pp. 406; 96 illustrations in the text. $1.20, net.

This little book was written primarily for technical students, metallurgists and engineers. It has the advantage of being short and, in general, accurate and clear. It also contains an unusually large amount of information for so small a space, and much of the data has not appeared in print before, but is evidently taken from personal experience. It was apparently written by one accustomed to teaching, and shows evidences of great care and thoroughness in its composition. The book contains a number of reproductions of photographs, which are well selected and so representative as to give an accurate idea of iron and steel operations, as well as to increase its interest greatly. It would have been much better if the writer had made more use of his illustrations for direct reference in his text, which would be easier to comprehend with this method of explanation: for example, the description of the open hearth furnace on page 105, of the gas producer on page 100, of the cup and cone on page 192.

One cannot help wishing that the book were not so brief, as many things are left out, apparently for the sake of brevity, which are of importance in direct connection with some of the information given. This can be explained by an example from page 160, where the writer says:

> The change in composition which pig iron undergoes while passing through the cupola—such as oxidation of iron, diminution in percentage of silicon and of manganese, increase in percentage of sulphur, and the slight increase in percentage of phosphorus—must, of course, be allowed for in making up the cupola charge. With well arranged and well finished molds of proper materials, suitable metal, attention to the best temperature at which to pour, and the rate at which the castings are allowed to cool, waste will be reduced to a minimum.

More data as to the amounts of the "changes" mentioned, the "proper materials," the "best temperature," etc., would indeed be very much appreciated here. In several places information of this kind would be very much more valuable than some of the subjects which he enters into at length, such as the details of lining furnaces. These things the engineer does not care to know, and the metallurgist or technical student need not know until he enters the works, where he can learn them very much more easily and quickly.

There are a few slight errors or omissions which it may be well to refer to: On page 97, in giving the composition of producer gas, the author does not mention nitrogen, the most abundant component of all, which leaves a wrong impression on the mind. On page 131, he says that the carbon should be removed after the phosphorus in the basic open hearth process, "as the commotion caused by the elimination of carbon (as gas) aids in quickly bringing the metal into more intimate contact with the slag." He omits to mention the important reason: that, if the phosphorus outlasts the carbon, a great deal of iron will be wasted by oxidation, since the phosphorus is not as good a protection of the iron from oxygen. On page 58 he says, "We must admire in Sir Henry Bessemer . . . his generous acknowledgment of the assistance of R. F. Mushet and William Henderson in helping him to perfect his method of making mild steel." While this is Mr. MacFarlane's opinion, and as such is entitled to free expression, it is contrary to much that has been said and written of Sir Henry Bessemer's feeling and attitude in this respect.

The author has employed an unusual order of treatment in this book which he explains as follows:

> In plan the book differs from others on the subject. Hitherto it has been usual to consider, firstly, the iron ores, and then the several processes for the production of finished articles. The author has, however, found it better to begin with a consideration of the finished products, as they are more simple in composition and much more familiar than the ores. Some years' experience of each system has convinced the author that the new method is superior to the old. But as each chapter is self-contained, the reader, student, or teacher may follow either plan without inconvenience.

Unquestionably his treatment of the subject is usually clear, but putting last the manufacture of pig iron, from which all the other materials are made, leaves the memory a little confused as to the relations of the different processes to each other. Moreover, the book lacks that logical sequence which assists so much in keeping up the interest. Of the individual chapters, those on the puddling process and tool steel are the best, while the discussion of steel castings and the short chapter on malleable castings are very far below the general standard.

*Adjunct Professor, Department of Metallurgy, Columbia University, New York City.

Marine Boilers.

Reviewed by Wm. Kent,* M. Am. Soc. M. E.

MARINE BOILERS.—Their Construction and Working, Dealing More Especially with Tubulous Boilers. Based on the Work by L. E. Bertin, Late Chief Constructor of the French Navy. Translated and Edited by Leslie S. Robertson, Secretary of the Engineering Standards Committee, M. Inst. C. E., M. Inst. M. E., M. Inst. Naval Architects, etc., etc. With a new chapter on "Liquid Fuel," by Engineer-Lieutenant H. C. Anstey, R. N., Assoc. M. Inst. C. E., M. Inst. M. E., and a preface by Sir William White, K. C. B., F. R. S. Second Edition, revised and enlarged. New York: D. Van Nostrand Co. Cloth; 5¾ × 9 ins.; pp. xxvi. + 658; 350 illustrations, mostly in the text. $5, net.

The first edition of this book was published eight years ago and was reviewed in Engineering News on Nov. 9, 1899 (page 312). The author is a distinguished French marine engineer and his book originated in a course of lectures given to the students of the Ecole d'application du Génie Maritime. It treats of the history, development and details of construction of various types of marine boilers. Early history is dealt with very briefly and even the Scotch boiler is passed over in a few pages. The greater part of the book is devoted to the water tube boiler, which for marine purposes had its chief early development in France, although now it is in universal use in the navies of the world. The work is rather of a historical and descriptive character than technical and systematic. Designers of marine boilers will find in it a great variety of useful information concerning different styles of water tube boilers and may learn from it how many bad ways there are of designing such a boiler, but they will not find any instruction on the subject of how to design and proportion a marine boiler which is to occupy a certain limited space and evaporate a certain quantity of fuel. In fact, the science and art of the designing of water tube boilers for marine purposes, being now in the transitional stage, it is scarcely possible to write a satisfactory treatise upon it.

The present edition contains a new chapter on liquid fuel written by Engineer-Lieutenant H. C. Anstey, R. N., and also the final report of the British Boiler Commission on water tube boilers. In this report, dated June, 1904, the Committee said that it was now satisfied that two types of water tube boilers, the Babcock & Wilcox, and the Yarrow, large tube, are satisfactory and are suitable for use in battleships and cruisers without cylindrical boilers. "Each type has its particular advantages, and only long experience on general service can show which is on the whole the better boiler." The report further says that a great improvement in economy of the Babcock & Wilcox boiler has been made in recent years by changing the arrangement of the heating surface and furnace gas baffling. Trials in 1898 showed from 59 to 66% efficiency; in 1901 from 63 to 73%; in 1903 from 66 to 76%, and after modification the same boiler showed on one occasion the high efficiency of 81%. In this case baffling of the furnace gases was by a vertical system which caused a zigzag flow of the gases from the heating surface, and in addition a forced air supply was introduced above the furnace.

The book contains interesting information on experiments of mechanical stoking in marine practice, and also on dust fuel stoking. It concludes with the statement that after repeated trials at sea of the various systems of mechanical stoking they had to be abandoned and the human stoker with his shovel and rake again installed.

Numerous tables of results of evaporation tests of different types of boilers are given. A study of them will lead to the conclusion that high and low economy, both, can be obtained from any kind of a boiler, and, as in the case of the Babcock & Wilcox tests, the question of obtaining economy is one of the proper burning of the coal in the furnace and of proper handling of the gases of combustion rather than of the structure of the boiler itself.

On the whole, the book is to be commended as the most satisfactory treatise on water tube boilers from the historical and constructive standpoint of which the reviewer has knowledge.

*Dean of College of Applied Science, Syracuse University, Syracuse, N. Y.

MECHANICS' PROBLEMS FOR ENGINEERING STUDENTS.—By Frank B. Sanborn, M. Am. Soc. C. E., Professor of Civil Engineering in Tufts College. Second Edition, revised and enlarged. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ × 8¼ ins.; pp. 194; 100 figures in the text. $1.50.

The revision of this book and the addition of a considerable number of problems will increase its usefulness, and should add to its popularity.

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A German Treatise on Structural Steel Work.

Reviewed by Leon S. Moisseiff, Assoc. M. Am. Soc. C. E.*

DIE EISENKONSTRUKTIONEN DER INGENIEUR-HOCHBAUTEN.—A Textbook for Use in Technical Schools and in Practice. By Max Foerster, Professor of Structural Engineering at the Dresden Royal Technical College. Supplementary Volume to "Handbuch der Ingenieurwissenschaften." Third edition, revised and enlarged. Leipzig, Germany: Wilhelm Engelmann. Paper, 7½ × 11 ins.; pp. 674; 1,000 figures in the text and 19 folding plates; many tables. 44 marks; American price, $10.

For a quarter of a century the German engineering profession represented by its ablest theoreticians and practitioners has been building up the monumental work of the "Handbuch der Ingenieurwissenschaften." It covers the main branches of what is generally comprised under the term civil engineering, and is known the world over for the high standards observed in its pages. It is diligently kept up to date by new editions and frequent supplementary sections are published to fill gaps or cover new fields. Professor Foerster's work on the iron construction of engineering buildings was published in 1902 for the first time as a supplementary volume to the above-mentioned series, and it now appears in its third edition.

As a supplementary volume the book was clearly intended to fill the demand for a modern work which should satisfy the needs of the ever growing subject of iron and steel construction outside of bridges and viaducts. As such it admirably answers the purpose, not because there are no similar works in the German language—the reviewer knows of an excellent treatise on the same subject published in the early seventies—but because the whole subject is treated by Professor Foerster in such a comprehensive manner that his work stands out as the latest achievement in a well worked field. The work shows that marked tendency which, more than anything else, indicates the progress of engineering science, to put every kind of construction on a scientific basis and to apply rational methods down to everyday details.

While recognizing the careful study devoted to many problems, the American reader is surprised to find that what constitutes the greatest number of steel structures in the United States, the steel skeleton building of the skyscraper type, is entirely ignored. In fact, the whole subject of the tall, self-contained steel building with its frequently difficult foundation problems and large wind areas and moments receives no treatment in the book. Of course, a skilled designer will be able to gather from the data given and from principles and elements discussed enough to deduce his own methods of treatment, but the matter is of an overshadowing importance and its omission is hardly excusable in a work so comprehensive. This is all from the American point of view; evidently our European colleagues esteem matters differently and there may be little demand for skyscrapers in Germany. Perhaps the author considers the steel skeleton not as an engineering but as an architectural structure, and does not consider its proper place to be in this work.

The book is splendidly illustrated and its 1,000 figures in the text and 19 folding plates furnish numerous examples of structures and details. Contrary, however, to what we have become used to expect, the structures described are confined almost exclusively to German practice. Little attention is paid to what has been done outside of the Fatherland. This exclusiveness becomes also apparent on a perusal of the valuable bibliographies which follow each chapter. Little attention is given to European literature outside of Germany, and practically none to American literature. If the book were the work of a French or English author, this would prove surprising and nothing could really be said against such exclusiveness. The volumes of the "Handbuch der Ingenieurwissenschaften" have, however, always served as a model of the broad view in engineering practice, in fact, they have always been a repository of the best practice the world over. Barring these deficiencies rather than defects, the book is full of valuable matter and the reader will be delighted to find there studies of many a vexatious problem.

The aim of the book is evidently to furnish the designer of steel structures other than bridges and viaducts with all the information he may require in his work without referring him back to some other source. The first fifty pages are, therefore, devoted to the materials used and to the unit stresses and proportioning of individual members. The author bases his proportioning of columns on the well-known Tetmajer experiments and adopts the column formulas established by the latter. As is well known, Tetmajer found that for wrought iron and steel the straight line formula holds up to a proportion of 90 to 110 of the length to the radius of gyration of the member; for higher proportions the Euler formula holds true. A useful table of what is termed the "coefficient of stiffness," or the relation of the square of the least radius of gyration to the least side of the various shapes, is given. This is followed by some 110 pages on members and details, divided into chapters on rivets, pins and bolts, panel point connections, columns and beams and trusses. The author takes the correct view that for structures of the kind considered pin connections have no advantages to offer, and that riveted joints are preferable. Numerous sketches of both cast iron and steel columns are given and several pages are devoted to the computation and design of poles for the support of overhead electric wires. The various methods of computing the stresses in beams and trusses for fixed and moving loads are given for simple as well as continuous and cantilever beams.

The bulk of the book, more than 300 pages, as well as its great value, lies in the section on roofs. Here in nine chapters the author covers all possible roof construction in a thorough and comprehensive manner. This matter will prove very useful to the engineer who is confronted with one of the more difficult problems of roof structures and has to search for special memoirs and periodicals for the analysis required. The chapters are on iron roof construction in general, simple roof trusses, cantilevering roofs, arched roofs, cupolas, pyramidal roofs, dutch, saddle and Foeppel's basket roofs and the covering of metallic roofs. The subject is treated exhaustively and is completely up to date on the present development of trusses in space. The bibliography on this theme furnishes very useful information to every student of this novel subject. Among the additional chapters the one on iron standpipes and the principles of the guide frames of gas holders deserve special notice.

The book is concluded with a section of 60 pages on the principles of reinforced concrete construction and its application to engineering structures, intended as a guide for the designer who has to deal with this form of construction. The author does not agree here with the well-known Prussian specifications which assume the ratio of the coefficients of elasticity of the steel to that of the concrete at n = 15, and recommends the ratio n = 10. While it is true that, as the author endeavors to show, a considerable variation in the value of n results in but a slight change in the compressive resistance of a member, the assumption of n = 10 is hardly justified. Based on the triangular stress-strain curve and the neglect of the tensile resistance of the concrete the author deduces the ordinary formulas for rectangular and tee-beams.

Tables of properties of standard shapes rolled in Germany, weights, ultimate strength of various materials, and the like are added, and also which may be noted, a Greek alphabet. An index completes the book. The book is well gotten up and the illustrations and plates are of the very best.

From the foregoing the reader may gather that Professor Foerster's work will be a very useful aid both to the student and the designing engineer, and is worthy of its position in the famous engineering series.

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A Popular Book on Turbine Engineering.

TURBINES.—By W. H. Stuart Garnett, of the Inner Temple, Barrister-at-Law. London, Eng.: George Bell & Sons. New York: The Macmillan Co. Cloth; 5⅛ × 8¾ ins.; pp. 283; 83 figures, mostly in the text. $2.75.

The author of the book is stated, on its title page, to be a "barrister-at-law." The reviewer, therefore, naturally opens the book with small expectations, for it is an exceedingly rare thing to find a book by a layman on a technical subject thoroughly well written. It is pleasing, therefore, to be able to state at the outset that the author has produced an excellent and useful work. It is, as the author states in his preface, a popular, rather than a scientific or technical, work; but it is a popular work of a most excellent sort—the sort that is calculated to instruct rather than merely to interest or amuse, and in which the instruction is given in such plain and simple terms that it can be understood by the non-technical reader. It is our experience that this class of books performs a much larger function in public education than the more abstruse and technical works which are commonly supposed to rank on a higher plane. Forney's "Catechism of the Locomotive," for example, has

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probably done more to extend knowledge of locomotive engineering among professional engineers, as well as among engine runners, than all the other works on the locomotive ever written.

There are many other departments of engineering which are waiting for other M. N. Forneys to make clear in plain and simple language the elementary facts and principles. There is particularly a demand for a popular book on turbine engineering. The book before us seems to meet this demand in excellent fashion.

It will be understood, of course, that in 275 pages of rather small size no very complete treatise on turbine engineering can be written. Much must be omitted of necessity; and one of the chief tests of the author's ability is his decision as to what to omit and what to include. Part I. of the book, containing 105 pages, is devoted to water turbines. It is on the whole less satisfactory than Part II., relating to steam turbines, particularly with respect to the early history of water turbines. It is fair to say, too, that the author's sources of information have been chiefly English engineers and English technical literature; and there is throughout a larger inclusion of English work and experience than would have been the case with an American author. On the other hand, the Pelton wheel and the Curtis steam turbine are given good space; and in other ways it is clear that the author endeavored so far as possible to write from a broad point of view.

On the whole the book is one which we can heartily recommend to American purchasers.

Radio-Activity.

Reviewed by Charles Baskerville.*

THE ELECTRICAL NATURE OF MATTER AND RADIO-ACTIVITY.—By Harry C. Jones, Professor of Physical Chemistry in the Johns Hopkins University. New York: D. Van Nostrand Co. Cloth; 5¼ × 8¼ ins.; pp. 212. $2.

The book is the outcome of a series of articles by the author in the "Electrical Review." It is written in non-mathematical language and the subject is gracefully presented.

The subject is treated in chapters under the following headings: The Electrical Conductivity of Gases, The Determination of the Mass of the Negative Ions in Gases, Nature of the Corpuscle and the Electrical Theory of Matter, The Nature of the Atom in Terms of the Electron Theory, The X-Rays, The Discovery of Radium, Other Radio-active Substances in Pitch-blende, The Alpha Rays, The Beta and Gamma Rays, Other Properties of the Radiations, The Production of Heat by Radium Salts, Emanation from Radio-active Substances, Helium Produced from the Emanation, Induced Radio-activity, Production of Radio-active Matter, Theoretical Considerations, Wide Distribution of Radio-active Matter and the Origin of Radium, Most Recent Work on Radio-activity.

Professor Jones is an enthusiastic writer, distinguished for his energy and dash. His vigor carries one along at such a rate that, did one not know better, he would be convinced of certain statements often not proved, or forget that there is another side to the question.

One reads (p. 2) "The removal of the conducting power (of a gas) by filtering through glass-wool shows that the conductivity of the gas is due to some constituent which is filtered out mechanically by the glass-wool. . . . The charged particles in a conducting gas are known as *ions*." Then on p. 14, after explaining the work of J. J. Thomson on the mass of the negative ion in gases and comparing it with a univalent ion in an electrolyte, according to the hypothesis of electrolytic dissociation, one sees, "Therefore, the value of M (mass of the ion) for the gaseous ion is about one thousandth the value of M for the hydrogen ion in solution." Again on p. 15, "The mass of this negative ion which can be split off from any gas is much less than the mass of the lightest so-called element known to the chemist."

This may or may not be true, but if it be true, what about the law of the diffusion of gases?

On p. 3 we read, "When an acid, base, or salt is dissolved in water, we know that it breaks down into charged parts called ions." Do we *really* know this? Frankly, it is the assumption of a modern school, which has many followers. Most recent work indicates that there are other explanations as satisfying as this, or that this hypothesis does not explain satisfactorily at all.

When the subject of radium is reached, it is treated very gracefully by summarizing Rutherford's work. The fact that the work is written for a popular audience can do no harm, as the popular audience could not understand much of it anyhow. It can scarcely be looked upon as a full authoritative treatise, as it fails to give both sides of one phase of the question, namely, the inactivity of thorium. Perhaps this is not serious. In ten years all of the present conceptions of radio-activity will have undergone marked modifications.

An excellent account is given of the "radiobes" of Burke and the suggested explanations of his observations.

Undoubtedly the discovery of the Becquerel rays, radium, the elucidation of the phenomena of the emanation have put us upon a new plane for the future interpretation of the physical and chemical laws of nature. Professor Jones summarizes this condition on p. 202, "The existence of extremely penetrating forms of radiation, the instability of the chemical atom, the formation of one elementary substance from another, the existence of a form of matter that can charge itself electrically, that can light itself, and that can give out an amount of heat that is almost inconceivably great, are some of the facts to which we must now adapt ourselves."

There is an excellent index and the typography is good.

*Professor of Chemistry and Director of the Chemical Laboratory, College of the City of New York, New York City.

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By F. LAVIS,
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Resident Engineer Pennsylvania Railroad Tunnels.
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Although several books have been written on railroad location, this is the first that combines detailed instruction on modern American methods of location with data on the estimating of quantities and unit prices. For example, tables and diagrams are given in this book, showing at a glance the number of cubic yards of masonry (concrete or stone) in standard railroad bridge abutments and piers of different heights. In like manner, the amount of materials in standard trestles of different heights, yardage in arches of different spans, the weights of steel in bridges, etc., are given. Contract prices for every variety of work are given to assist in making estimates. Every practical railroad engineer will recognize the value of such aids as these in making preliminary estimates of costs. The author is himself a railroad locating engineer of wide experience, and is at present Resident Engineer, Pennsylvania Railroad Tunnels. This book treats not only of estimating the cost of railroad work, but it is the most thorough treatise on the practice of railroad location that has yet been published. The various problems that occur in location are splendidly and profusely illustrated with line drawings. In fact, no other book on the subject contains half as many typical illustrations of location problems. Mr. Lavis goes into the details of the organization of parties, and camp equipment, the keeping of notes and mapping—in fact, every detail of field and office work is described. Since the first publication of Mr. Wellington's great work, no author has produced a railroad location book so full of original matter as this new volume. Wellington's book treats of the theory; this book by Lavis treats of the practice of location, and in addition it contains what neither Wellington's nor any other railroad book contains, namely, tables, diagrams and data for estimating the cost of railroad construction. The book is bound in cloth, 6 x 9 ins., and has about 250 pages, and 76 illustrations, including many folding plates. Its price is $3 net, postpaid.

READY IN SEPTEMBER

Concrete and Reinforced Concrete Construction

By HOMER A. REID,
Assoc. M. Am. Soc. C. E.,
Asst. Engr., Bureau of Buildings, New York City.

Before any of the three recent books on concrete was published, the manuscript of a book on reinforced concrete was submitted to us by Mr. Homer A. Reid. We asked the author to make additions to his work so as to cover the whole field of concrete construction, plain concrete as well as reinforced concrete. It seemed wise to do this, in view of the fact that there is so much in common between plain and reinforced concrete. The author agreed with us, and undertook the task of enlarging his work to cover thoroughly the whole field of concrete construction. In the meantime, three books on concrete have appeared, but not one can be truthfully said to discuss the two kinds of concrete with equal thoroughness, and, in fact, only one of the three books claims to do so. We believe, therefore, that "Concrete and Reinforced Concrete Construction," by Reid, is the only complete treatise on the general subject of concrete. This book is more profusely illustrated than any book on concrete or reinforced concrete yet published, which is a feature that will commend it particularly to the designing engineer. It contains, moreover, the most thorough discussion of the theory of reinforced concrete beams, columns, foundations, etc. Almost every class of structure built of reinforced concrete is illustrated in detail and described. For example, a reinforced concrete railroad trestle, with bents 50 ft. high, is among the latest additions to the book. Chimneys, water towers, bins, buildings, retaining walls, arches, etc., of the latest designs are shown, as well as forms, centering, etc. The author is an engineer experienced in concrete work, and is at present engaged as Assistant Engineer in the Building Department, New York City. Cloth; 6 x 9 ins.; about 600 pages.

Send for Table of Contents

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Electric Wave Telegraphy.

Reviewed by Samuel Sheldon.*

THE PRINCIPLES OF ELECTRIC WAVE TELEGRAPHY.—By J. A. Fleming, M. Inst. E. E., etc., Professor of Electrical Engineering in University College of the University of London. London, New York and Bombay: Longmans, Green & Co. Cloth; 5¾ x 9 ins.; pp. 671; folding and other plates and many text illustrations. $6.60, net.

This most admirable treatise is, to a large extent, based upon the author's Cantor Lectures delivered before the Society of Arts in London upon the subjects, "Electric Oscillations and Electric Waves" (1900), "Hertzian Wave Telegraphy" (1903), and "The Measurement of High Frequency Currents and Electric Waves" (1905). The book is divided into three parts treating respectively of electric oscillations, electric waves, and electric wave telegraphy.

The first part gives the theory of the production of high frequency currents and electrical oscillations, the results of the efforts of experimenters to verify this theory and the construction and practical operation of experimental and commercial apparatus for the production of these currents; the various methods of measurement, at high frequencies, of resistances, inductances, capacities, currents, and potentials as well as many other methods of calculating these quantities from other easily determined physical and geometrical characteristics, including a discussion of the properties of dielectrics; the methods of calculation and practical determination of the logarithmic decrement of electrical oscillations, and the general theory of resonance. This part, written in the characteristic style of the author, will make the book invaluable to workers on the subject, because of its completeness. It contains the results of experiment and mathematical analysis obtained by others, digested, correlated and augmented under the wide experience of the author.

The second part gives the mathematical theory of stationary electric waves, the experimental conditions necessary for their production in straight and spiral wires, and the excitation of fundamental and harmonic oscillations in earthed and inductively coupled antennae; the general properties of an electro-magnetic medium, the production of waves in it, and the formation and detachment of closed loops of electric strain with illustrative diagram by Pearson and Lee, showing the radiation of electric strain and the forms of lines of electric force around a Hertzian dumb-bell oscillator for different epochs. This part also has a very interesting and suggestive chapter on the detection and measurement of electric waves, in which the construction and principles of operation of various forms of coherers, and magnetic, electrolytic, thermal, electrodynamic, vacuum-tube, and oscillating-valve symoscopes is treated with great particularity.

The third part treats of the inception, development and present practice and principles of electric wave telegraphy. This part must prove of great value to those directly interested in the art for, besides the historical presentation, there is much original matter which, as a result of the close connection between the author and the Marconi Company, is of great practical value. The oscillation constants, and the radiation decrements of various types of antennae and the absorption and dissipation of electromagnetic waves cannot be satisfactorily determined from experiments carried out on less than a commercial scale.

The book seems destined to occupy the same place in the field of oscillatory currents as the author's work on the Alternating Current Transformer did in the field of ordinary alternating currents. It is a book deserving the careful attention of the student, of the physicist, and of the engineer, as well as of the telegrapher.

*Professor of Physics and Electrical Engineering, Polytechnic Institute, Brooklyn, N. Y.

STATE WATER SUPPLY COMMISSION OF NEW YORK.—First Annual Report for Year Ending Feb. 1, 1906. (Henry H. Persons, President of Commission; Myron S. Falk, Consulting Engineer.) Albany, N. Y.: Pub. Doc. Paper; 5¾ x 8¾ ins.; pp. 208; six folding plates.

An appendix gives summarized descriptions and statistics of most of the public water supplies of the municipalities of the state and also information regarding sewage disposal.

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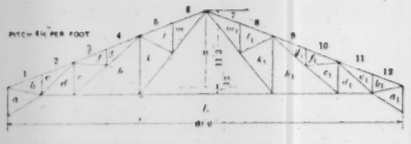

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Electrical Engineering.

Reviewed by Henry H. Norris.*

ELECTRICAL ENGINEERING IN THEORY AND PRACTICE.—By G. D. Aspinwall Parr, M. Sc., M. I. E. E., A. M. I. Mech. E., Associate of the Central Technical College, City and Guilds of London, Head of the Electrical Engineering Department, The University, Leeds. London, Eng.: Macmillan & Co., Ltd. New York: The Macmillan Co. Cloth; 6 × 9 ins.; pp. 447; 282 figures in the text. 12s., net; American price, $3.25, net.

THE PRACTICAL TESTING OF DYNAMOS AND MOTORS.—By Charles F. Smith, Assoc. M. Inst. C. E., A. M. I. E. E. Second and enlarged edition. Manchester, Eng.: The Scientific Publishing Co. Cloth; 5¾ × 8¼ ins.; pp. 306; 108 figures in the text. 5s., net; American price, $2.

It is no small task to undertake a thorough survey of the field of electrical engineering in a single work, as the title of Professor Parr's book indicates to be his intention. The present volume treats only of the elements of the subject and it is to be amplified later or possibly followed by a second volume, the new material to comprise electrical machinery and its applications. The first volume is an admirable treatise, written in a rather informal style, but with clear explanations and following a logical and consistent plan. The subject is approached from the standpoint of physics rather than of the practical engineer, but the treatment is not theoretical merely, but leads to practical and sound conclusions.

There are three chapters dealing with the fundamental facts and laws regarding magnetism and statical and current electricity. Then follow three chapters dealing with the inter-related subjects, resistance, electro-magnetism and induction. The remainder of the work is of a more practical nature and covers measuring instruments, incandescent lamps, and the thermal and chemical production of electro-motive force. The theoretical section of the book is of the nature of an advanced text-book of physics. A careful study of this will serve to lay for the student a firm scientific foundation for his more practical engineering reading. Only the most elementary mathematics are employed and the algebraic expressions are applied to numerical examples in order to convey a working knowledge of the principles illustrated. At the end of each chapter are numerical, practical problems which can be solved from the text and which are so designed as to stimulate interest by showing that the student is learning to do something with his new knowledge.

The more practical division of the book is descriptive in style, each chapter very thoroughly covering the topic assigned to it. A general discussion in each case leads to detailed descriptions of numerous typical examples which are adequately treated. A commendable feature is the practice of supplying a perspective view and a diagram of each important device. The illustrations, as a rule, are distinct and complete, and they are well placed with respect to the accompanying text, in most cases being in view without turning the page while the text is being read. The chapter on instruments includes examples for making all kinds of scientific and practical electric and magnetic measurements. The names of the inventors of the instruments are generally foreign, as the book deals almost entirely with English practice. However, the principles employed are exactly similar to those found in American types, so that the book suffers small loss in value to readers in this country. This is particularly true as the descriptions are intended to illustrate scientific principles and further, it will harm no reader in the United States to be familiar with the practice abroad. In treating of the subject of electric lighting the author gives excellent information regarding the manufacture and the economical operation of the several kinds of lamp. That the chapters are up-to-date is indicated by the inclusion of the latest types of Nernst and vapor lamps as well as incandescent lamps having osmium and silicon carbide filaments. Similarly such new arc lamps as the electrolytic and magnetite types are described and the direction of the progress in arc lighting is indicated. The chapter dealing with the production of electromotive force is evidently intended as a preliminary treatment of the subject leading up to the generation of power for engineering purposes. The principle of the electro-thermal couple is explained and data are given for calculating the electromotive force produced by various elements at all temperatures. Several primary cells are shown and a section is devoted to indicating the manner in which the electromotive force of a cell may be predetermined. This is followed by a discussion of the secondary battery up to but not including its applications in engineering.

Each practical chapter, as well as each of the theoretical ones, is followed by a series of questions to serve as a review of the work covered. These questions were all taken from the examination papers of the City and Guilds of London Institute, each question being followed by a statement of the time and nature of such examination. These questions are well chosen and arranged, and form a distinct addition to the other features. The work as a whole differs somewhat from other books on the market. In general its field may be said to be similar to that with the same title by Slingo and Brooker, which is also an English book. It will be read with profit by practical engineers desiring a broad general view of the principles of electrical engineering practice. It is also an excellent text-book for technical students beginning a course in mechanical or electrical engineering. It is well printed and bound and does not require the gilt edges which the publishers have provided in order to indicate the real worth of its contents.

Mr. Smith's work is a manual of direct current dynamo and motor testing, and it forms a companion volume to "Practical Alternating Currents," by the same author, reviewed in these columns (September 14, 1905). A commendable feature of both books is the directness and simplicity of the treatment, all the statements being carefully verified by experiment. The method followed in the different chapters is the same and consists first of a brief statement of the facts which are to form the basis of a group of experiments. The working directions for performing typical experiments are then given and following each is a discussion of the facts which the results of the experiments should disclose. These deductions are based upon the actual results obtained, apparently, by the author, the data being given in graphical form for convenient reference. Although the curves exhibited are obtained from small dynamos and motors, and hence must be used with care if referred to in criticising the performance of larger machines, they clearly indicate the characteristics of the different classes of apparatus. The instructions for performing each experiment are accompanied by a simple and attractive diagram of connections, each conventional figure being lettered for reference to an accompanying key. An outline for a blank form for use in entering readings and calculations is also included in each case.

It is evident from the above analysis of the contents of the book that while it is primarily a laboratory manual it contains profitable reading matter even for a student who has not access to laboratory facilities. The style and contents make it interesting and its freedom from mathematics will render it useful to many readers whose training has been of a practical rather than a theoretical nature. As there are no descriptions of machines or instruments, it is necessary for the user of the volume to familiarize himself with these either by a direct study of the apparatus itself or by reading descriptive literature. The omission of much of this material ordinarily found in text-books permits of an ample treatment of the subject of testing in a book of moderate size. The printing and engravings are good and, while the cover is not attractive, it is evidently designed to withstand hard usage in the laboratory, and its bright red color will prevent its being easily mislaid.

In comparing Mr. Smith's book with others it may be said that it occupies the same field as "Testing of Electro-Magnetic Machinery," by Swenson and Frankenfield, and the "Testing of Continuous Current Machines," by Charles Kinzbrunner, and it is somewhat similar to each of these. It is, however, distinctive in several particulars and the fact that it has reached a second edition in a comparatively short time after publication is an indication that it is meeting an actual requirement. [See this Supplement for Nov. 12, 1903, for a review of the first edition.—Ed.]

Electric Railway Tests.

ELECTRIC RAILWAY TEST COMMISSION.—Report to the President of the Louisiana Purchase Exposition. Members of the Commission: J. G. White (Chairman), Geo. F. McCulloch, James H. McGraw, H. H. Vreeland, W. J. Wilgus. New York: McGraw Publishing Co. Cloth; 6 × 9½ ins.; pp. 621; 209 illustrations, mostly in the text, and 102 tables. $6, net.

A series of tests on electric railway cars and auxiliary apparatus was conducted in connection with the Louisiana Purchase Exposition, in 1904, by an Electric Railway Test Commission organized upon the initiative of the Exposition's Department of Electricity. The tests began on June 15, 1904, and were completed March 22 of the following year. The original project for the work was based on the view that

> the presence of a large amount of electric railway apparatus, gathered together for exhibit purposes, offered an exceptional opportunity for obtaining practical and scientific information of equal interest to the producer and to the user of electrical machinery.

Advisory committees made up of prominent

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By C. L. Crandall

Professor of Railroad Engineering and Geodesy at Cornell University.

This book is the outgrowth of lecture notes which have been in use for quite a number of years in Cornell University. Professors desiring to examine this work with a view to introduction will kindly communicate with the publishers, who will forward the copies on the day of publication to addresses given.

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*Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

electrical engineers formulated comprehensive programs of tests, in various grades of electric railway work; but

the tests actually performed by the Executive Committee [a working organization appointed by the Test Commission] in several instances departed widely from those outlined in the suggestions of the Engineering Committees. The Executive Committee would have been more than pleased to have carried out the wishes of the Engineering Committees, but in the instances mentioned it was found impracticable to do so, either because of the hesitancy of manufacturers to permit certain apparatus to be tested or to a lack of facilities for testing, and in some instances to both of these conditions.

The tests made by the Commission include Service tests of a single truck city car, two-truck city car, and an interurban car; Acceleration Tests of a city car and an interurban car; tests of a compressor station supplying a storage air-brake system; Braking tests of city and interurban cars, with air-brakes and magnetic track brakes; Stand tests of a motor-compressor; tests of a storage battery industrial locomotive; Determinations of alternating-current losses in lengths of various steel and iron sections and in actual street-railway track; Train resistance tests with an interurban car and with a special air-resistance test car, "Louisiana;" Air-resistance tests with the special test car "Louisiana."

This list shows clearly that the interest of the tests lies not in the novelty of the objects of experiment but in the detailed results, if anywhere. As a matter of fact the bulky volume which contains the Report is so filled with detailed results that a separation of the new and not-new can be accomplished only by close analytical study of the whole book. Generally it may be said that the major portion of the results is a duplication of information already available in electrical literature, obtained from tests made by manufacturers, operating engineers, and thesis groups. To this extent the present tests are merely of comparative and confirmatory value. Individual items scattered through this part of the tests, however, contained more pronounced value and interest. Thus, in testing an industrial locomotive for starting power, figures for the zero or friction current, that is the minimum value of current which produced any drawbar pull at all, were obtained. In starting on a curve with this same locomotive the increased current required to produce a given drawbar pull in spite of the curve-compensating arrangements of the wheels, was measured [but this interesting detail was not pursued farther nor were similar figures obtained for cars on regular tracks]. The braking tests give some valuable comparisons between hand, air and magnetic brakes, and supply data on the power consumption of the latter two and on the extra motor heating due to the magnetic brake current; they also exhibit the imperative need, in such tests, of a reliable device for indicating or recording acceleration, and the unsatisfactory character of acceleration curves computed from velocity curves.

Two parts of the testing work which bear special interest are: (1) the determinations of alternating-current losses in pieces of rail and in complete track, and (2) the air-resistance tests made by means of the special test-car "Louisiana." The tests of alternating-current losses in rails show some surprising figures. Thus, an 80-lb. Am. Soc. C. E. rail showed the following values of loss ratio, that is, impedance ÷ direct current resistance,

	At current of— 100 amp.	200 amp.
At 10 cycles	2.9	5.0
At 20 cycles	5.4	7.4
At 30 cycles	6.8	8.8
At 40 cycles	8.5	10.9
At 50 cycles	10.3	12.9
At 60 cycles	12.2	14.8

the power-factor being in the neighborhood of 80% [between 75% and 90%]. The corresponding tests on track, about 1,000 ft. of double-track line with a trolley-wire over each track, showed for the track alone, with currents between 100 and 600 amperes:

	Single rail.	Single track.	Double track.
At 15 cycles	3.0- 4.5	2.6-4.0	2.5-3.0
At 25 cycles	4.3- 5.5	3.8-5.5	3.2-4.0
At 40 cycles	5.7- 8.2	5.3-7.3	4.7-6.0
At 60 cycles	8.0-11.0	8.0-9.8	7.0-8.0

which ratios, while tending to increase as the current is increased, are much more constant than in the case of the pieces of rail tested on the stand.

The report of these rail-loss tests is rendered less valuable than it should be by the omission (in the graphical summary diagrams) of the points denoting the individual observations, in the first part. The curves alone being given, no idea is afforded of the degree of concordance of individual results, or of how close the agreement between the faired curves and the observations. More doubt is, in consequence of the same omission, thrown on the diagrams in at least one instance, by the fact that the curve of loss-ratio, if produced down to zero amperes, would pass through 0.3 to 0.5, instead of through 1.0 [as it should, and does in the other diagrams]. There may be many other such errors, especially as all the diagrams are reproduced by the wax-engraving process. A related fault, but one which cannot be charged against the process of engraving, is the poor quality of the half-tone illustrations throughout the book.

The air-resistance tests were made mostly with a special car, the "Louisiana," fitted with devices by which the pressure on the front face, the longitudinal force on roof and sides, and the suction on the rear could be separately measured. The results obtained with this car, while valuable and suggestive in many respects, are far too few and incomplete to permit of drawing condensed deductions, as the Report expressly acknowledges. Enough work was done with the car to show (1) that consistent test results could be obtained, (2) that wind resistance is of very great importance in high-speed running, (3) that the rear-end resistance is always present and varies from 8 to 25% of the head resistance, (4) that the shape of ends is of little influence on total resistance at speeds below 40 mi. per hr., but is very important at speeds exceeding 50 miles, especially in limiting the speed which can be attained with a given motor equipment. The test car was turned over to Purdue University at the close of the work of the Commission, and will there be used for further investigations by that institution in conjunction with the American Street and Interurban Railway Association. The results of this future work will doubtless supplement the results obtained by the Commission, in such a way that fuller conclusions can be drawn.

Publications Received.

BAU UND BETRIEB VON KAELTEMASCHINENANLAGEN.—Tables, Data and Text Suggestions for Engineers, Public Officials, Owners of Refrigerating Plants, etc. By C. Heinel, Instructor in the Berlin Technical College. Munich and Berlin, Germany: R. Oldenbourg. Cloth; 5½ × 8½ ins.; pp. 251; 19 plates (two in pocket), 108 text illustrations and many tables. 12 marks; American price, $4.80.

BULLETINS, THE MINING BUREAU, MANILA.—(H. D. McCaskey, Chief.) Manila, P. I.: Pub. Doc. Paper; 5¾ × 9 ins.
No. 4: A Preliminary Reconnoissance of the Mancayan-Suyoc Mineral Region, Lepanto, P. I. By A. J. Eveland, Geologist, Mining Bureau. Pp. 58; 43 plates.
No. 5: The Coal Deposits of Batan Island, with Notes on the General and Economic Geology of the Adjacent Region. By Warren D. Smith, B. S., M. A., Geologist, Mining Bureau. Pp. 56; 21 plates (one in pocket) and eight text figures.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.
No. 280: The Rampart Gold Placer Region, Alaska. By L. M. Prindle and Frank L. Hess. Pp. 54; seven plates and one text figure.
No. 281: Results of Spirit Leveling in the State of New York for the Years 1896 to 1905, Inclusive. By S. S. Gannett and D. H. Baldwin. Pp. 112.
No. 282: Oil Fields of the Texas-Louisiana Gulf Coastal Plain. By N. M. Fenneman. Pp. 146; 11 plates and 15 text figures.
No. 288: Results of Spirit Leveling in Pennsylvania for the Years 1899 to 1905, Inclusive. By S. S. Gannett and D. H. Baldwin. Pp. 62.

THE CORROSION AND PROTECTION OF METALS.—With Special Reference to the Preservation of Engineering Structures. By A. Humboldt Sexton, F. I. C., F. C. S., Professor of Metallurgy in the Glasgow and West of Scotland Technical College. Manchester, Eng.: The Scientific Publishing Co. Cloth; 5 × 7½ ins.; pp. 147. 5s., net; American price, $2.

GEOLOGIC ATLAS OF THE UNITED STATES.—U. S. Geological Survey, Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Stiff paper; 18½ × 22 ins.
No. 135: Nepesta Folio. Colorado. Pp. 5; three plates and two text figures.
No. 136: St. Marys Folio. Maryland-Virginia. Pp. 7; two plates and one text figure.
No. 137: Dover Folio. Delaware-Maryland-New Jersey. Pp. 10; two plates and one text figure.

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ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.—Proceedings at the 1906 Meeting. Chicago, Ill.: The Society (E. E. R. Tratman, Secy., 1536 Monadnock Block). Paper; 6 × 9 ins.; pp. 200; illustrated. 50 cts.

THE IMPROVEMENT OF HONOLULU.—By Charles Mulford Robinson. (Rochester, N. Y.: The Author.) Paper; 6 × 9 ins.; pp. 37; one folding map and one text figure.

THE INTERMITTENT FILTRATION OF SEWAGE AS PRACTICED IN AMERICA.—Address given before the Royal Institute of Public Health, London, 1905. By Prof. Leonard P. Kinnicutt (Worcester, Mass.). Paper; 5½ × 8½ ins.; pp. 13.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Vol. XXVI. 1th Meeting, New York, N. Y., 1904; 1List Meeting, Scranton, Pa., 1905. New York: The Society (12 West 31st St.). Half morocco; 6 × 9 ins.; pp. xl. + 841; 292 illustrations, mostly in the text. $11. (In paper covers, $10.)

NATIONAL FIRE PROTECTION ASSOCIATION.—Proceedings of 1906 Meeting, Held in Chicago, May 22-24. Chicago, Ill.: The Secretary (W. H. Merrill, Jr., 382 Ohio St.). Paper; 5¼ × 9 ins.; pp. 292; illustrated.

OCEAN AND INLAND WATER TRANSPORTATION.—By Emory R. Johnson, Ph. D., Professor of Transportation and Commerce in the University of Pennsylvania, Member of the Isthmian Canal Commission, 1899 to 1904, Author of "American Railway Transportation." New York: D. Appleton & Co. Cloth; 5¼ × 7¾ ins.; pp. 395; folding plates and text illustrations. $1.50, net.

PROFESSIONAL PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 × 11¼ ins.
No. 45: The Geography and Geology of Alaska. A Summary of Existing Knowledge, by Alfred H. Brooks. With a Section on Climate, by Cleveland Abbe, Jr., and a Topographic Map and Description Thereof, by R. U. Goode. Pp. 327; 34 plates (one in pocket) and six text illustrations.
No. 47: The Tertiary and Quaternary Pectens of California. By Ralph Arnold. Pp. 264; 53 plates and two text illustrations.
No. 49: Geology and Mineral Resources of Part of the Cumberland Gap Coal Field, Kentucky. By George Hall Ashley and Leonidas Chalmers Glenn, in Cooperation with the State Geological Department of Kentucky, C. J. Norwood, Curator. Pp. 239; 40 plates (one in pocket) and 13 text illustrations.

SEWAGE DISPOSAL AT MANCHESTER AND BIRMINGHAM.—By Prof. Leonard P. Kinnicutt (Worcester, Mass.). Reprinted from Journal of the Association of Engineering Societies, Vol. XXXVI., No. 3. Paper; 6 × 9¼ ins.; pp. 123 to 130; two plates.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Proceedings of the 1905 Meeting, held in Atlantic City, N. J. Vol. XIII. Edited by Charles L. Crandall, Fred W. McNair, Milo S. Ketchum, Committee. New York: Engineering News Publishing Co. Cloth; 5¾ × 9 ins.; pp. xl. + 324; text illustrations and one folding plate. $2.50, net.

STATE BOARD OF HEALTH OF CONNECTICUT.—Annual Report for the Year 1905, with the Registration Report for 1904 Relating to Births, Marriages, Divorces and Deaths. New Haven, Conn.: Pub. Doc. (No. 25). Cloth; 6 × 9¼ ins.; pp. 295; plates.

STATE BOARD OF HEALTH OF MICHIGAN.—Report of the Secretary, for the Fiscal Year Ending June 30, 1904. Lansing, Mich.: Pub. Doc. Cloth; 6¼ × 9¼ ins.; pp. xxxiv. + 221; illustrated.

WATER SOFTENING AND TREATMENT.—Condensing Plant, Feed Pumps and Heaters for Steam Users and Manufacturers. By William H. Booth, M. Am. Soc. C. E., Author of "Liquid Fuel and Its Combustion," "Smoke Prevention and Fuel Economy," "Steam Pipes; Their Design and Construction." New York: D. Van Nostrand Co. Cloth; 5½ × 8¾ ins.; pp. 208; 92 text illustrations and 42 tables. $2.50, net.

THINGS THAT ARE USUALLY WRONG.—By John E. Sweet. New York: Hill Publishing Co. Cloth; 5¼ × 7¾ ins.; pp. 49; 50 illustrations in the text. 50 cts.

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